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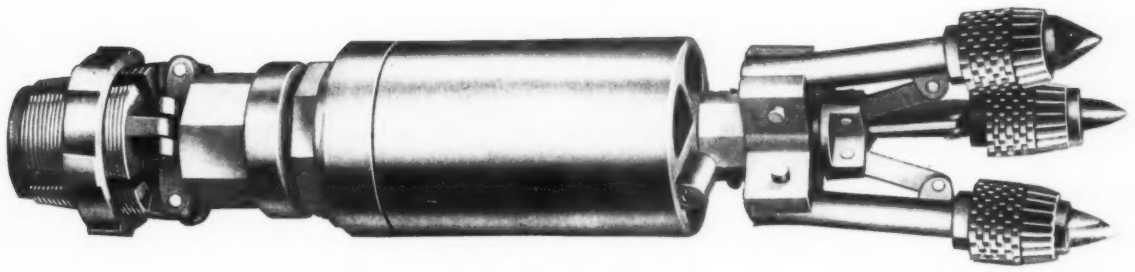
POWER AND THE ENGINEER

ISSUED WEEKLY BY THE HILL PUBLISHING COMPANY, 505 PEARL STREET, NEW YORK.

Vol. 29. Index to Advertisers and Classified Index Following Reading Matter No. 24.

"HIGH POWER"



BOILER TUBE CLEANER

This powerful, high-class Boiler Tube Cleaner has demonstrated its splendid value in so many large power plants in all parts of the country that we would much rather send you one on FREE trial than go into details about it in this space.

Sufficient to say that the "HIGH POWER" is made expressly for large plants where cost is a factor and can be had in two distinct styles, one for air—one for water.

If the best results at the lowest expenditure, both of time and money, are what YOU want, then write for a "HIGH POWER" today and test it for yourself; we are willing to rely on its merits to effect a sale.

The "Rapid" Hose Clamp and Coupling combined (as illustrated above) is *guaranteed* to hold fast. Saves time and patience.

THE THOMAS ANDREWS MFG. CO.

ROCKAWAY, NEW JERSEY

About This Time Of The Year

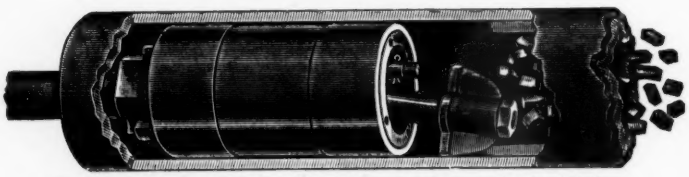
many concerns begin to think of shutting down their boiler plants for their annual overhauling and cleaning.

Next year is going to be a mighty busy one. You'll want to make use of every day of it. Not a day of it must be wasted. So you'd better start right.

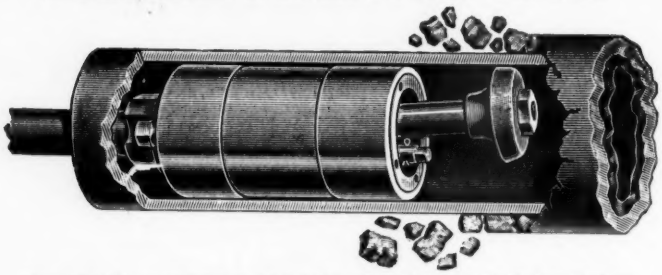
A clean heating surface on your boiler tubes is the first thing you should consider. Neglect this and you'll waste coal, get poor steaming, and shorten the life of your boilers. Remove the soot and scale. And don't rely on somebody's mere statement that your tubes are clean. Investigate the matter and be sure.

The DEAN Boiler Tube Cleaner

cleans the tubes of all kinds of boilers and condensers—both sides—soot and scale—because it does it by vibration. It will remove scale thoroughly in less time, at smaller expense and with greater ease than anything you have ever used. Try the DEAN in one of your boilers—we'll loan it to you, free of charge, for this purpose. The trial will convince you that you do have scale and that the DEAN is the only thing that will remove it.



The DEAN working in the tube of a Water Tube Boiler.



The DEAN working in the tube of a Return Tubular Boiler.

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Send your request today for the three articles shown above. They're absolutely free because we want you to know

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Fill out and mail to us the attached coupon at once. One pound of Keystone Grease lasts longer and lubricates better than 3 to 4 pounds of any other grease, or 4 to 6 gallons of the best lubricating oil. This offer is worth accepting.

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H. P. of Engine.....

On what bearing will sample be tested?

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Its width.....

R.P.M.....

Size of tap for cup.....

Dec. 15.-08, Dept B.

MAKE NO MISTAKE

ONLY THE PACKING WITH THE BIG RED "D" IS GENUINE

P.P.P. PACKING

We've adopted this big Red "D" solely to **protect** you from the horde of imitations that unscrupulous dealers are offering as "Just as good as P. P. P." A great feature of Daniel's P. P. P. is the gland pressure. You know how it is with most packings—jam up the gland **hard,** result—**heavy friction on rod.** How different with P. P. P.—set the gland up with the finger and thumb **just to the packing.** That's all! Should it leak or blow, give it time to warm up and get set to the rod. If it does not take up within a reasonable time, set the gland up firm against the packing to compress it slightly for a minute or two, then immediately set the gland back as far as it will go, without leaking, and leave it alone. There is no resistance to be overcome by the rod traveling back and forth, as there is with other packings where the gland is set up hard and the packing jammed in tight.

Write today for our P. P. P. booklet.

QUAKER CITY RUBBER CO.

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VOLUMES have been written authoritatively on the excess cost of producing a given horse-power in boilers that are coated with incrustation. Scale one-thirty-second to one-sixteenth inch thick increases the fuel consumption ten to fifteen per cent., and greater scale thickness means greater loss of heat.

In these times of keen competition, when the greatest manufacturing economy must be exercised, the Engineer, Superintendent, Manager, Owner, are vitally interested in reducing these unnecessary operating expenses.

That the boiler water troubles are being successfully handled by the Dearborn Company, in 11,000 steam plants, keeping boilers clean, and preventing waters from pitting boilers and tubes, the work being done under a combination scientific laboratory and practical engineering guidance, should appeal to the discriminating operator desiring to better results.

Gallon samples of waters required for analysis, after which we will tell you how to remedy the troubles you experience, and the cost to do it right.

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Be Sure It's A Genuine Smooth-On Gasket

It is impossible for any imitation to possess the one greatest feature of our gaskets—the coating of Smooth-On Elastic Iron Cement, for we are the sole manufacturers.

If you would be absolutely sure of perfectly tight joints, whether hot or cold, see that the gaskets you buy bear the Smooth-On label.

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WE COULD SAY A LOT ABOUT **GARLOCK PACKING BUT** IT ONLY NEEDS ONE TRIAL TO **CONVINCE YOU** THAT IT IS THE VERY PACKING THAT YOU WILL ALWAYS DEMAND ON FUTURE REQUISITIONS

TRY IT AND SEE!

Garlock Combination Packing Style No. 222

For Air Rods On Compressors

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1886-1908 WIN THE LAUREL WREATH Sales 500,000

The World's Standard Boiler Feeder

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BOILER CORALLINE COMPOUND

REG. U.S. PAT. OFFICE

Coralline, when used as a boiler compound, stands for something.

It means when properly applied that your steam boilers will not form the least particle of scale and that the old scale will disappear so the sheets and tubes will be perfectly clean.

It will prevent pitting, stop any foaming or priming in boilers, do away with all bad effects of oil and reduce the fuel account.

Give us a chance to prove this at our expense. Send us a gallon of your steam boiler feed water or a piece of the scale formed from the same water you intend to use.

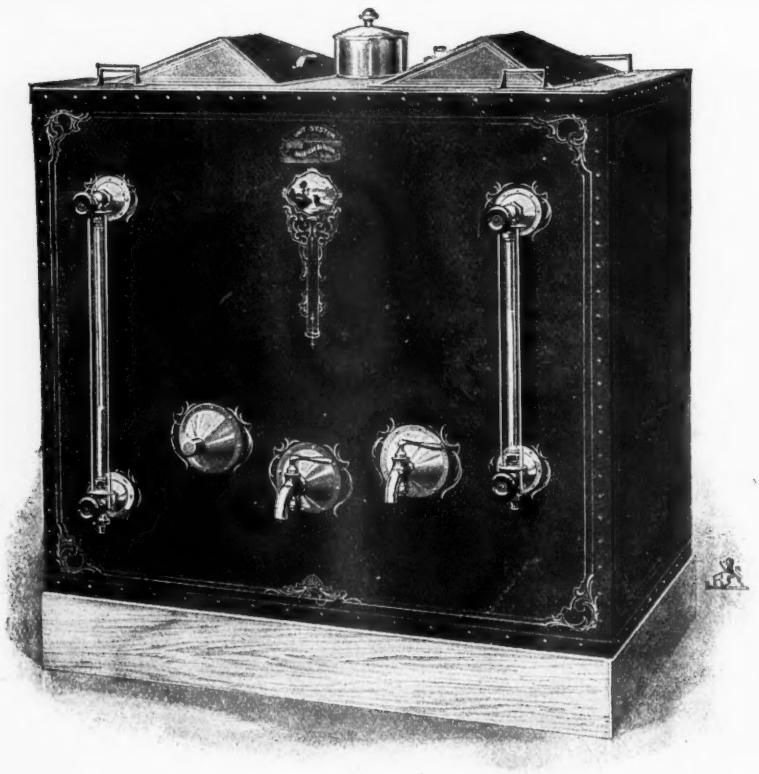
We will analyse the same free of cost, and at your request we will prepare you a barrel of compound suited to take care of this water, ship the goods to you, freight prepaid to destination, and charge you nothing for the compound.

We think this is a fair and reasonable proposition and we solicit your business on this basis.

Mark on your order to us that it is subject to the above representation.

Coralline Drug & Chemical Co.,

465 Greenwich St., New York, N. Y.



Another "Burt" Unit Filter For The Kodak People

Read What They Have To Say:

EASTMAN KODAK COMPANY
Rochester, N. Y.

The Burt Mfg. Co., Akron, O. June 17, 1908.

Gentlemen—Replying to yours of the 12th inst., would say we have installed a second of your latest improved "Unit Type" oil filters. The results obtained in the operation of an engine by having a continuous stream of pure oil delivered to the bearings is far superior to the old scheme of lubrication from oil cups. We are, therefore, very well pleased with the unit filter system and are convinced that the same will result in considerable saving, not only in the oil but in the life of the engines.

Yours truly,
Eastman Kodak Company,
P. E. Wilcox, Ass't Mgr. Kodak Park Works.

Send for our new 96-page Catalog.

THE BURT MFG. CO., 232 Main St., Akron, O., U.S.A.

Largest Manufacturers of Oil Filters in the World.

We also manufacture a complete line of Exhaust Heads and Ventilators.

City Investing Building's Power Plant

A Modern Plant Featured by Ash Handling Facilities, a Novel Arrangement of Station Buses and Unusual Method of Cooling Boiler Room

BY THOMAS WILSON.

The latest addition to the large number of buildings owned by the City Investing Company, of New York City, is the handsome new office building recently completed at 165 Broadway. This building occupies a frontage on Broadway, Cortlandt and Church streets and rises to a hight of 33 stories. From an artistic standpoint the building is a model, and this is apparent upon the first entrance into the arcade, which is magnificent in its simple but costly design. Money has not been spared to equip the offices with all modern conveniences in the way of lighting, heating, telephone and elevator service, and the many other little features demanded by the present-day tenant. John McKay was in charge of the entire mechanical installation from start to finish and is superintendent of the many buildings owned by the City Investing Company.

To light a building of such proportions and install the necessary equipment for elevator service required a plant of some magnitude, and in compliance with usual practice this plant was located in the basement. It is divided into what we may call the engine room, boiler room and workshop, the former containing besides the generating units, the elevator and house pumps, and in the boiler room the feed pumps associate with the boilers, but treat them to nothing thicker than water. The engine room, with its tile floor, walls of white pressed brick, asbestos-covered pipes and highly finished machinery painted red and black with a few brass trimmings for the pumps, presents a very attractive appearance and is a plant which Edward Baxter, operating engineer-in-charge, is proud to show to his friends or to visitors interested in his department.

Generating Equipment

A near approximation of the total number of lights in the building is 22,000 sixteen-candlepower incandescents. To supply all these lights with current and also the necessary current for 105 horsepower of motors, the engine room is equipped with four generating sets, all of which supply direct current. Three of these units are rated at 300 kilowatts each and the fourth has a capacity of 150 kilowatts. The engines are all of the Wetherill tandem-compound Corliss type, the three largest having dimensions 17x32x36 inches, and the small engine,

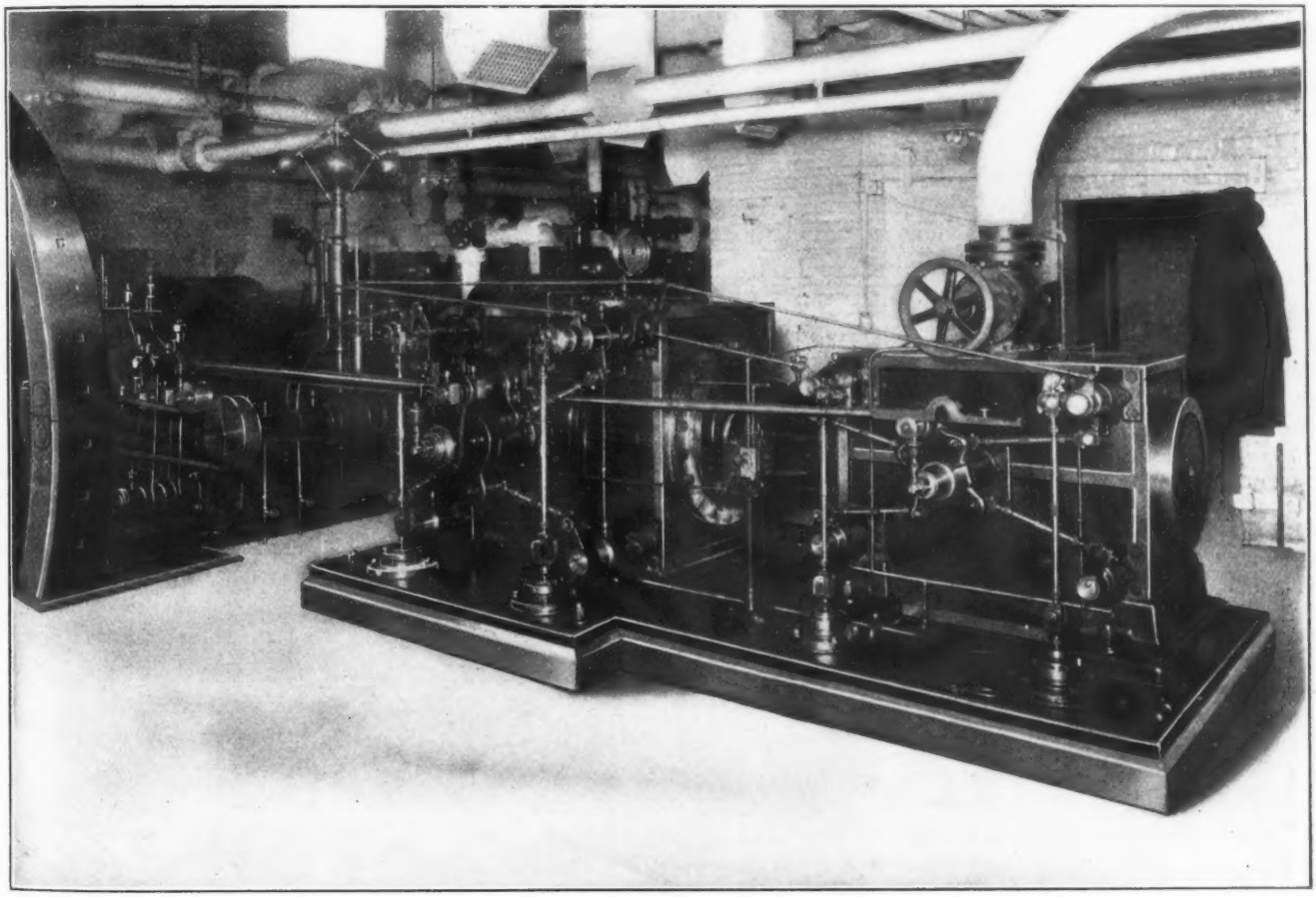


FIG. I. VALVE-GEAR SIDE OF ONE OF THE LARGE CORLISS ENGINES

12x20x30. All revolve at 110 revolutions per minute, run noncondensing, and are direct-connected to Westinghouse direct-current compound-wound generators. The engines are of a type in common use, and the details of their valve gear is apparent in Fig. 1. Aside from this, some of the essential features of the design are as follows:

The valves are plain castings adapted for high-pressure work, and on the front end are provided with a T-slot to receive the T-head of the valve stem. The connection between the cylinder and girder frame is made by turning a recess in the end flange of the frame and fitting it over the front cylinder head, securing it to the cylinder by studs. The crank arms are secured to the valve stem with inside keys, these being provided with threaded ends and drawn to place by a nut against an outer plate which covers the end of the valve stem. The governor is of the centrifugal flyball type, and to it is attached the usual safety device. The adjustment of the crosshead shoes is effected by inside wedges and adjusting screws, and the front end is provided with an interlocking plate to facilitate the removal of the shoes. Lubrication of the crosshead pin is effected by a center oiling device with a wiper cup mounted on the end of the pin receiving oil from a stationary cup mounted on the engine frame. Adjustment of the connecting-rod boxes is effected by wedges and adjusting screws, the screws entering the wedges from each side.

Lubrication of the bearings is effected by a gravity oiling system in which the oil from the engine-crank pits is drained by gravity to a combination receiving tank and filter. From here the oil is pumped to a tank in the boiler room at an elevation considerably above the engines and is then fed by gravity to the bearings. When it is desired to replenish the oil, the fresh supply is simply poured into the crank pits. Cylinder lubrication is effected by Richardson sight-feed oilers on all the engines, as well as the pumping equipment. As to the efficiency of the engine units no very definite data are obtainable, only that they come within the guarantee of 19 pounds of water per horsepower-hour.

Novel Arrangement of Buses

In the electrical equipment a feature of interest is the individual panel for each machine and the buses supported above and extending the full length of the generating installation. Each panel is a blue Vermont marble slab supported on angle iron attached to the floor and ceiling, the same risers affording attachment for the brackets carrying the buses. The instruments on each panel are a Weston voltmeter and ammeter, and a recording wattmeter. In addition, the panel is equipped with a Cutler-Hammer circuit breaker on each side and a single-pole single-throw knife switch on the equalizing bus. The panel and bus arrangements will be noted in Fig. 2. All are the same, and between panels the thoroughly insulated buses are supported on angle iron hung from the ceiling. At each end the buses tap into feeder boards, one of these containing three panels and the other five.

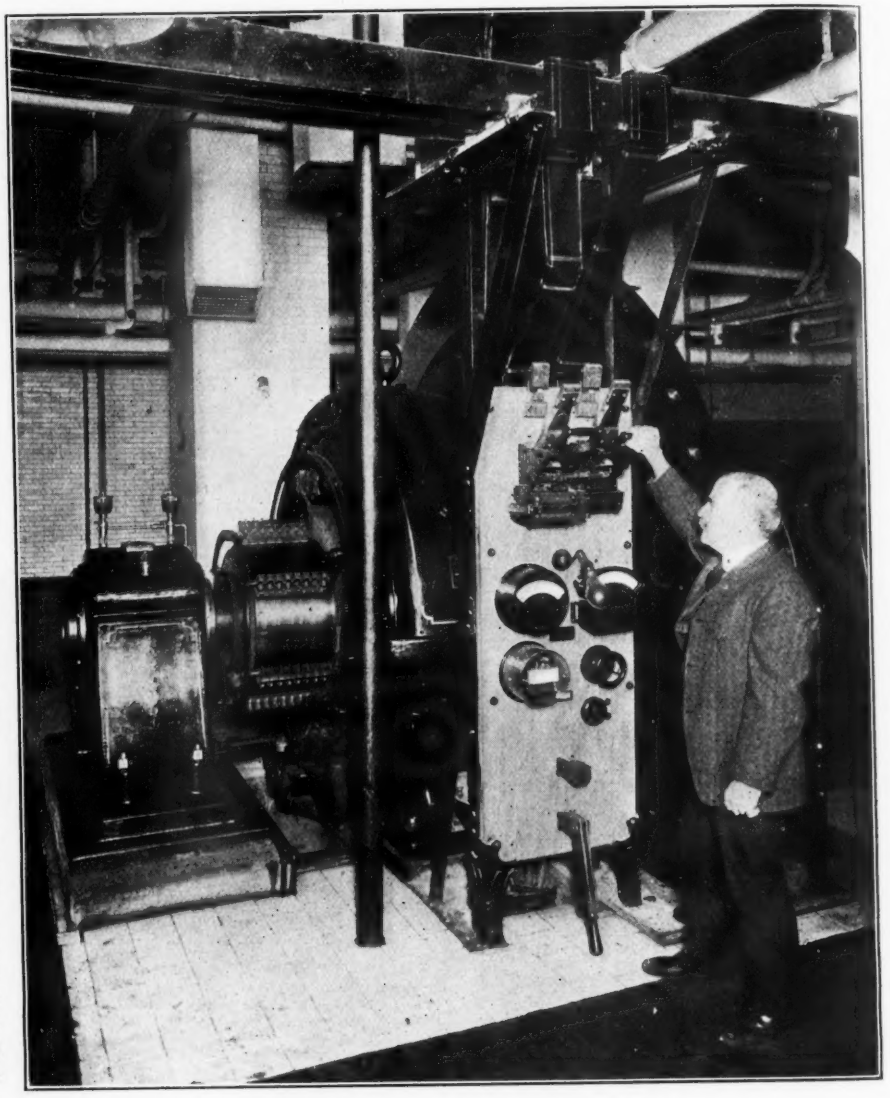


FIG. 2. GENERATOR PANEL AND BUS ARRANGEMENT

With the exception of a station instrument panel, the entire set of eight panels is given over to feeder switches controlling the various circuits of the building. On this instrument panel is a Weston ammeter for each machine, one large station voltmeter of Weston make, and two graphic recording ammeters. The boards are of Westinghouse construction throughout, and the supply circuits are arranged for three-wire 110-volt distribution.

Boilers

In this division of the plant are five Babcock & Wilcox water-tube boilers, four of which are rated at 450 horsepower each, one at 350 horsepower, and all carrying a pressure of 175 pounds gage. The larger boiler units are equipped with 210 four-inch tubes, 18 feet long and arranged 21 wide by 10 high. The three drums are 42 inches in diameter, 23 feet 3⅝ inches long by ½ inch thick, and both drums and tubes are made of open-hearth steel of 56,000 pounds tensile strength. The boilers were built to withstand a pressure of 200 pounds per square inch. The 350-horsepower boiler contains but two drums of the same dimensions as the larger units and 180 four-inch tubes, 18 feet long and arranged 18 wide by ten high. The boiler equipment consists of McClave dumping and shaking grates, which have a grate surface 7 feet deep by 12 feet 6 inches wide on the larger boilers and a grate 7 feet deep by 11 feet 10 inches wide on the smaller; Babcock & Wilcox gages registering 300 pounds, Spencer damper regulators, Reliance water columns and U. S. automatic water gages which close automatically when the glass breaks, Foster nonreturn valves on the top of each boiler and Fairbanks stop cocks and Jenkins Y-valves on the blow-off complete the equipment. All blowoffs

are 2½ inches in diameter and tap into a common blow of the same size, discharging into a blowoff tank with connections to the sump and from thence to the sewer.

Handling Coal and Ash

Coal used for firing is No. 2 buckwheat and is brought to the plant by means of wagons. On the Cortlandt street side bunkers are provided with a capacity of 600 tons and on the Church street side additional capacity is provided for 200 tons of what is termed the "blizzard" coal, which is used only in times of emergency. The coal is hand-fired and is burned by means of natural draft furnished by a stack 500 feet in hight and 7 feet square all the way up. This is the highest stack, above the grates, in the world, and although no draft gages are provided, it is said that the firemen must wear lead soles on their shoes to keep them from going up the flue when the damper is fully opened. Perhaps this may be a slight exaggeration, but at any rate the draft is there "good and plenty." The stack is in line with the middle boiler, and the flue, which is 7 feet square, opens directly into the stack. On either side are straight flues, 4 feet square, serving the remaining four boilers. The flues are of steel construction covered with asbestos, and the steel lining continues to the top of the stack.

In a basement plant the removal of ashes is always a troublesome feature, and in this particular case it is accomplished by means of the traveling electric hoist, shown in Fig. 4. This apparatus was furnished by the Northern Engineering Works, and consists of a 2-horsepower running motor and a 6-horsepower hoisting motor, the latter having sufficient power to handle four cans of ashes at a time, as illustrated in the photograph. These cans are 18 inches in diameter by 24 inches high, and will carry in the vicinity of 200 pounds of ashes. The entire device runs on a 12-inch I-beam extending the full length of the boiler room and continuing to the sidewalk elevators by which the ashes are hoisted to the street and sold for filling or carted to the dump and from thence taken out to sea. The seat for the operator will be noted in the rear and the controllers on each side, so that the device can be readily handled at his discretion.

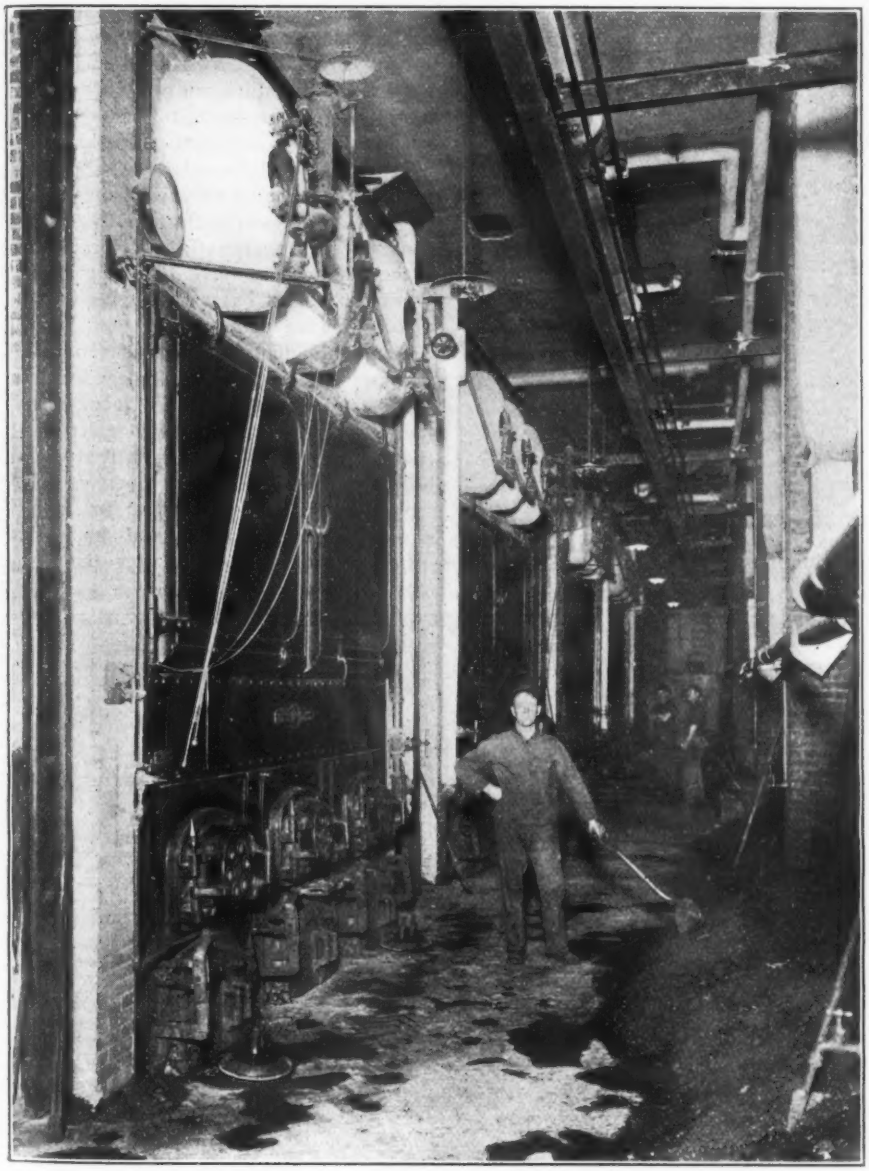


FIG. 3. A VIEW DOWN THE BOILER FRONTS

Cooling the Boiler Room

A feature of unusual interest in the boiler room is the method of introducing air under the grates. The system about to be described was designed by Messrs. McKay and Baxter, with whom we have already made an acquaintance, and as it has reduced the temperature of the boiler room from 180 degrees at the ceiling to a temperature approximating that of the air outside, its application in basement boiler rooms should prove desirable. Originally the cold-air inlets from the ventilating system extended down in front of the boilers about halfway from the ceiling. Consequently the fresh air was discharged against the boiler fronts and most of it went up the flue. The hot air was removed at the ceiling, and the temperature of 180 degrees or over, naturally resulting from these conditions during the summer months, was unbearable. Several plans were originated to overcome this difficulty, and it was finally conceived that if the air for the boilers was taken from a point near the ceiling and the fresh-air inlets extended to a point near the floor, allowing the cool air to circulate in front of the boilers, the temperature would be greatly lowered. To effect this a square galvanized-iron duct of a hight reaching to within 4 inches of the ceiling was placed on either side of one of the boilers. These ducts were 2 feet square and at the bottom communicated with the ashpit by a connection 1 foot high and flaring out at the boiler to 4 feet wide. This gave an inlet area of 4 square feet on each side, or a total of 8 square feet, which was nearly equivalent to the area of the ashpit doors. When these ducts were installed, all openings in front of the boiler were closed and all air was admitted by way of these ducts at the sides of the boiler. This arrangement reduced the temperature in front of this particular boiler to such an extent that it was decided to install them on the remaining four. The same plan was followed with the exception that a duct 3 feet square was used and served the sides of two boilers, so that only one duct would be required between each setting, always maintaining, however, the 8 square feet for admission of air to each boiler. With all boilers now equipped in this way the temperature of the boiler room need not exceed that of the atmosphere, at least on the floor, and on November 24 it was only 80 degrees Fahrenheit. During the winter months the supply of cold air must

be regulated or the temperature will be altogether too low for comfort.

Steam Piping

Communication between the engines, pumps and boilers is effected by two 10-inch headers, one of which is termed the main header and the other the auxiliary header. Each is suspended from the ceiling and is provided with U-bends at the center to allow for expansion. Cross connections between the two are made so that either can be used as desired. Leaders, 8 inches in diameter, connect the boilers and headers, and with two exceptions each boiler is provided with two leaders, one for each header. These lead out horizontally from a tee on the boiler outlet and run with a long sweeping bend to the headers. The two exceptions mentioned have but one connection, and this to the main header. The necessary stop valves are provided throughout. The three larger engine units are provided with 6-inch steam lines which have connection with both headers, while the small engine has a 4-inch line connected to the main header. The pumps receive their steam from reduced extensions of the main header. Exhaust pipes for the engines are 8-inch and 6-inch, respectively, and these tap into a common exhaust main 14 inches in diameter, which in turn discharges into a muffler on the engine-room floor and from thence the exhaust escapes to atmosphere when not needed for heating. On all steam and exhaust lines, which are covered with H. W. Johns-Manville asbestos, Fairbanks valves, with but few exceptions, are installed throughout, and Chapman valves on the water end. Sweet direct steam separators are installed on all steam lines to the pumps and engines, and Potter separators in each of the boilers, affording double protection against water. The Holly system of handling drips has been installed.

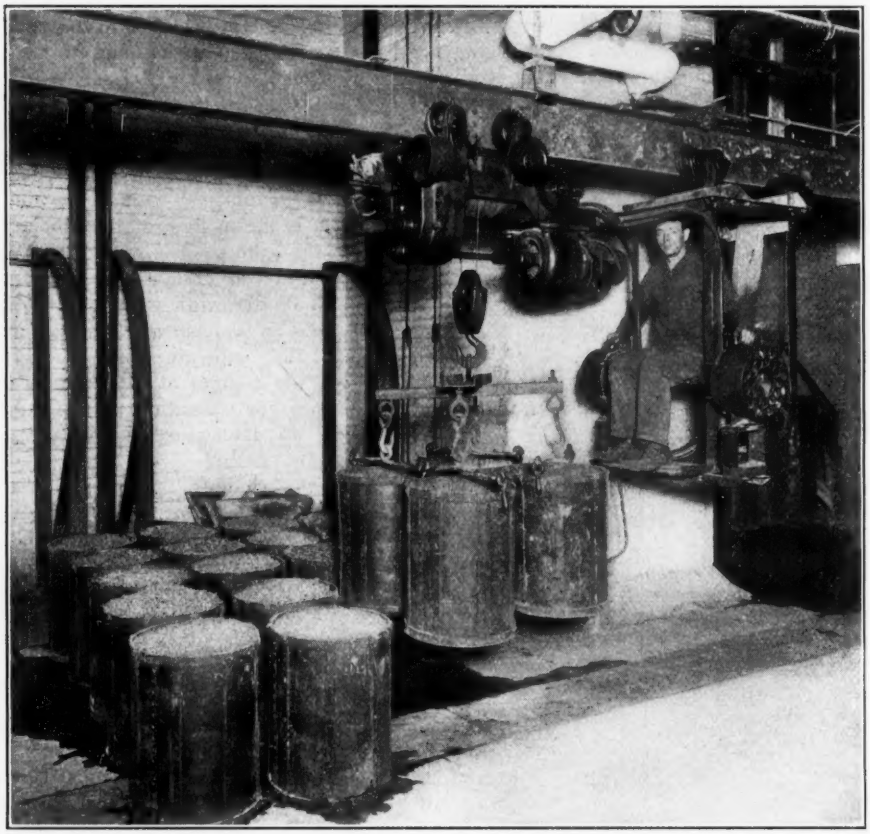


FIG. 4. CARRYING ASHES TO SIDEWALK LIFT

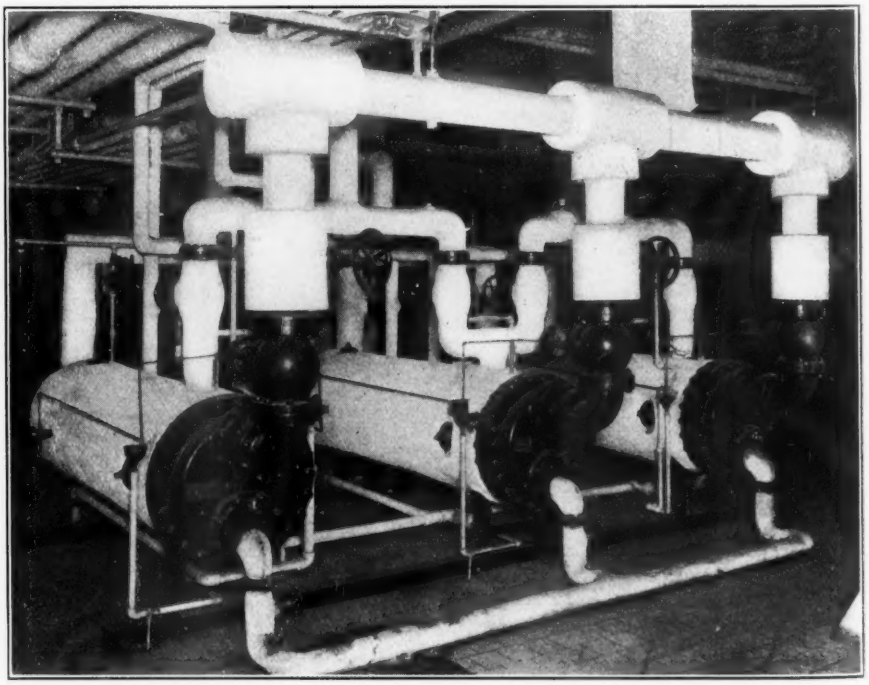


FIG. 5. BERRYMAN HEATERS WHICH SUPPLY BUILDING WITH HOT WATER

Heating System

For the entire building approximately 100,000 square feet of radiating surface is required, and in cold weather this will require 30,000 pounds of water per hour. The Webster vacuum system has been installed, and the exhaust steam from the engines and pumps is utilized at atmospheric pressure or below. The general supply of steam is taken from two 12-inch mains leading from the muffler previously mentioned. All risers leading up to the various radiators throughout the building are tapped into these mains and are offset near their connection to the main so that they can be readily drained. The returns are taken off from the opposite side of the radiators, and are collected in a common return main, termed the low-vacuum main. Condensation in this main is drained by McDaniel traps, and connection to the high-vacuum main, which is in direct communication with the vacuum pumps, is effected through a vacuum-regulating valve. If desired, this valve can be cut out and the system put directly on the pumps.

From the pumps the air and condensation from the system is discharged into a Webster air-separating tank, from which the water passes through a sealed discharge pipe to a Webster open feed-water heater of 2500 horsepower capacity. The separating tank affords release for the air and storage for the water, and should the water return at a rate faster than required to supply the feed-water heater, it is stored until the tank is entirely full, after which any additional water escapes

through the tank overflow and is wasted. On the other hand, to prevent the tank from emptying, an automatic-control arrangement is provided to admit cold water from the filtered-water mains of the plant just as soon as the level falls below the point at which the control is set to operate. There is also a bypass around the separating tank so that cold water can be supplied directly to the heater. Thr water leaves the heater through a 6-inch pipe at a temperature of 210 degrees and is conveyed to the feed pumps, of which there are three of Worthington make and any one of which is capable of taking up the supply and forcing it to the boilers through a 5-inch header extending the full length of the boiler installation. From this header 2½-inch pipes lead down to the control valve on each boiler and 1½-inch taps are made to this for each drum. There is no automatic feed control, as the supply of water is regulated entirely by the hand-operated control valve. Of the three feed pumps there are two having dimensions of 12x7x10 inches and one 10x6x10 inches. Any one of the three has sufficient capacity for any one time, so that there is plenty of reserve in feed pumps.

Ventilation

A ventilating system has been provided specially for the engine and boiler rooms. From the Cortlandt street side of the building air is admitted through the sidewalk into a vault 8 feet wide, 15 feet long and 15 feet high. On one end of this vault is a grating 7x11 feet through which the air is drawn by the suction of a 10-foot fan direct-driven by a 50-horse-

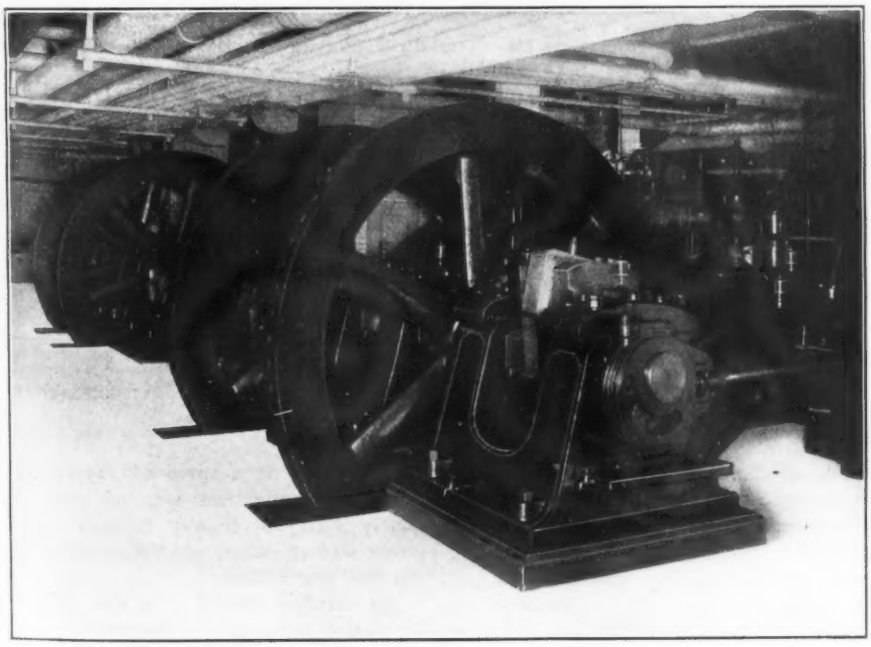


FIG. 6. FLYWHEEL END OF PUMPING ENGINES

power Diehl inclosed motor. In the air duct are tempering coils, and after the air has been heated to the proper temperature, it is passed through a Thomas & Smith "Acme" air purifier and cooler. In this device the air must pass through a solid sheet of water formed by a system of piping and a number of spray nozzles. In this way the impurities are removed from the air and the water is drained by a series of baffles to pans below, from which it is taken by a small motor-driven centrifugal pump and again forced through the nozzles. Every four or five days the water is drawn off to the sump and a fresh supply taken. After passing through this sheet of water the air is distributed through a series of air ducts and discharged into the engine and boiler rooms. An exhaust fan of the same type, only 8 feet in diameter and driven by a 40-horse-power motor, removes the foul and heated air, so that the engine room, as well as the boiler room, is much cooler and more comfortable than usual.

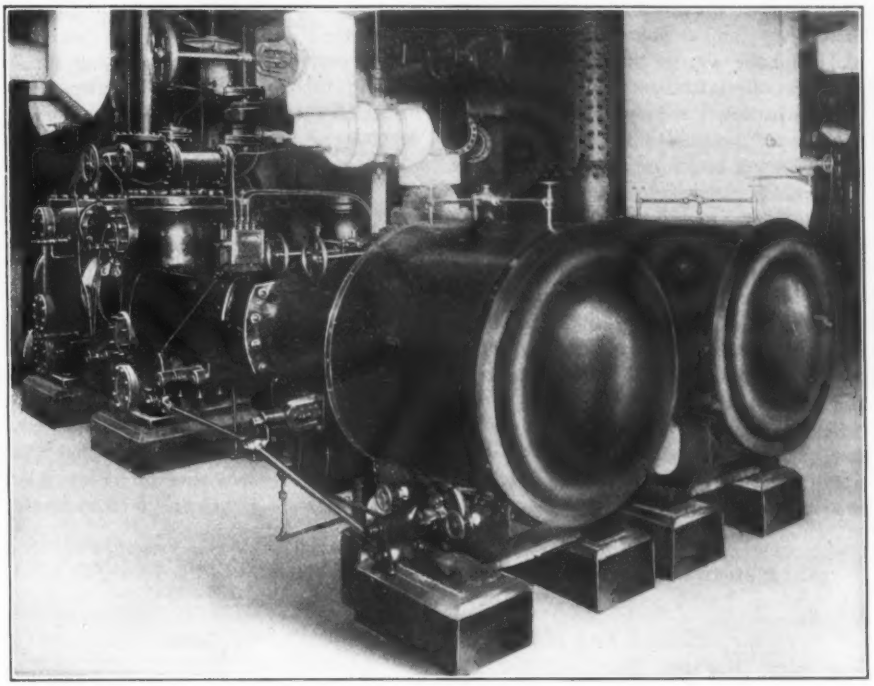


FIG. 7. THE RELAY FOR ELEVATOR SERVICE

Hydraulic Elevators

The elevator service of the building is good, and an extensive equipment has been provided. This consists of 21 Standard plunger elevators, two sidewalk hydraulic elevators and two Otis electric elevators, which run between the twenty-sixth and thirty-first floors. The hydraulic elevators are divided into one section of seven cars running to the twenty-sixth floor, one section of seven cars to the seventeenth floor, and the third section of seven cars to the ninth floor. The rise to the twenty-sixth floor is 365 feet. The plungers are 7 inches in diameter and the travel of the car 600 feet per minute. On the power end there are four Laidlaw-Dunn-Gordon pumps. Two of these are compound duplex outside-packed plunger pumps, one 14x20x10½x18 inches and the other 21x34x18x24. The former is capable of delivering 500 gallons per minute, running at a piston speed of 58 feet per minute, and the other 2500 gallons per minute when running at a piston speed of 94 feet per minute. There are also two pumping engines, each 18x24x24x12½x30 inches, capable of delivering 2350 gallons of water per minute. These pumps are controlled by Mason pressure governors and a Judson throttling governor belted to the main shaft. The pumping engines make 43 revolutions per minute and oper-

ate against 230 pounds pressure. Ordinarily the pumping engines carry the load. The large plunger pump is held as a reserve and the smaller one used on Sundays or holidays. In addition to these four pumps there is a jack pump for lifting safes to the offices. This is of the duplex type and is provided with a portable telephone set, so that the man lifting the safe can talk directly with the engineer operating the pump. In the engine room near the pumps are three 2000-gallon pulsating tanks on the pressure line. The discharge is made against a pressure of 15 pounds into six 10,000-gallon tanks. There are also three 8500-gallon elevator-pressure tanks on the thirty-second floor, besides three auxiliary pressure tanks of 2000 gallons capacity and three auxiliary discharge tanks of the same size, so that there is one of each for each bank of seven elevators.

Besides these elevator pumps there are three house pumps, all of Worthington make and each 14x20x10½x18. There are two systems of tanks for house and fire service, one on the fifteenth floor which supplies the building from the fourteenth floor down, and the other on the thirty-third floor, supplying water from the fifteenth floor up. There are independent supply pipes to the two sets of tanks to avoid pumping all the water against the enormous head of 500 feet, but any one of the three pumps can be used on either service. Kyle regulating valves control the pumps and there is also provided an electric tell-tale from the tanks.

Three Berryman heaters supply hot water for the use of the tenants. The water is taken from the supply tanks just mentioned, and with heads of over 200 and 500 feet, will readily force itself to the heaters and back up to the level desired. It may be of interest to mention here that all water for either house or boiler service is filtered, passing on its way in through Loomis-Manning filters, of which there are four having a capacity of 600 gallons per minute.

Miscellaneous

Of the little features which go to make up a thoroughly equipped plant, may be mentioned the private fire-alarm system of the building. On every floor there is an alarm box which will ring the engine room, boiler room and the main hall. On the first alarm the engine-room force is given a chance to extinguish the fire, but if they find that it is beyond their control, the city fire department is called, for which there is provision on every floor. There is also a private intercommunicating 36-station telephone system. This is arranged so that any one of the 36 stations can be called from the engine room, main hall and the superintendent's office; and any one of these three stations can be called from any floor. There is no communication between floors. The jack telephone system for safe lifting has been previously mentioned. Another feature worthy of note is the installation of two small motor-generator sets for taking care of all the bell service throughout the building. The generators are designed to deliver current at 15 volts, while the motors take current from the main buses of the station.

Cost of Oil Fuel

The accompanying table, showing the yearly crude-oil fuel costs per gross brake horsepower for various load factors and rates per barrel, was compiled in the office of Charles C. Moore & Co., San Francisco, Cal.

TABLE SHOWING YEARLY FUEL COSTS PER GROSS B.H.P. FOR VARIOUS LOAD FACTORS AND RATES PER BARREL—CRUDE OIL.

Relative Size of Plant.	Large.			Medium.			Small.		
Boiler efficiency running period, per cent	75			73			70		
†Barrels of oil per hour per B.h.p.	0.007144			0.007340			0.007654		
Curve load factor, per cent	100	50	33.33	100	50	33.33	100	50	33.33
Case I.	24 Hours per Day, Running Period.								
*B.h.p.-hrs. per year	8760	4380	2920	8760	4380	2920	8760	4380	2920
Total bbl. oil per year per B.h.p.	62.851	31.29	20.86	64.298	32.149	21.433	67.049	33.524	22.350
Cost of Oil per Bbl.	Yearly Cost of Oil per B.H.P., Dollars.								
0.75	46.93	23.47	15.64	48.22	24.11	16.07	50.29	25.14	16.76
1.00	62.58	31.29	20.86	64.30	32.15	21.43	67.05	33.52	22.35
1.25	78.22	39.11	26.07	80.37	40.18	26.79	83.81	41.90	27.94
1.50	93.86	46.93	31.29	96.45	48.23	32.15	100.57	50.28	33.52
2.00	125.16	62.58	41.72	128.60	64.30	42.87	134.10	67.05	44.70
Case II.	20 Hours per Day, Running Period.								
B.h.p.-hrs. per year	7300	3650	2433	7300	3650	2433	7300	3650	2433
Total bbl. oil per year per B.h.p.	52.803	26.627	18.036	54.252	27.461	18.531	56.572	28.635	19.323
Cost of Oil per Bbl.	Yearly Cost of Oil per B.H.P., Dollars.								
0.75	39.60	20.04	13.53	40.69	20.59	13.90	42.43	21.47	14.31
1.00	52.80	26.72	18.03	54.25	27.46	18.53	56.57	28.63	19.32
1.25	66.00	33.40	22.54	67.82	34.33	23.17	70.71	35.79	24.15
1.50	79.21	40.09	27.06	81.37	41.18	27.79	84.86	42.95	28.99
2.00	105.60	53.45	36.07	108.50	54.92	37.06	113.14	57.27	38.65
Case III.	10 Hours per Day, Running Period.								
B.h.p.-hrs. per year	3650	1825	1217	3650	1825	1217	3650	1825	1217
Total bbl. oil per year per B.h.p.	27.896	14.858	10.512	28.661	15.266	10.80	29.897	15.928	11.272
Cost of Oil per Bbl.	Yearly Cost of Oil per B.H.P., Dollars.								
0.75	20.93	11.15	7.89	21.49	11.45	8.10	22.43	11.95	8.46
1.00	27.90	14.86	10.51	28.66	15.27	10.80	29.90	15.93	11.27
1.25	34.86	18.56	13.13	35.83	19.09	13.50	37.37	19.91	14.09
1.50	41.84	22.28	15.77	43.00	22.91	16.21	44.84	23.89	16.91
2.00	55.79	29.72	21.02	57.32	30.53	21.60	59.79	31.86	22.54

† Values based on average oil, 18,500 B.t.u. per pound.
* 1 year = 365 days = 8,760 hours.
Standby or dead-load oil was figured as 5 per cent. of the hourly consumption based on 100 per cent. curve load factor and included in results as given.
Steam to burners included as part of load.

A Troublesome Crank Pin and Its Cure

By John I. Baker

Fig. 1 is a plan view of a horizontal twin tandem engine in which the troublesome crank pin is shown at *P*. The engine operated at a speed of 125 revolutions per minute, and was of approximately 2500 horsepower capacity. The stroke was 42 inches, and the piston speed 875 feet per minute.

The trouble started with the original connection between the disk, and Fig. 2 shows that the crank pin was riveted to the larger disk, while the end in the smaller disk was turned spherically, allowing free motion, similar to a ball joint. Two bronze boxes, with a spherical hole to fit

the crank pin, were placed in a square hole in the smaller disk, the flanges on one end keeping them from working out, while loose strips, held in place by tap bolts *T*, Fig. 2, kept the brasses tight against the pin.

strips and put in thin liners between the brass and disk. In about two weeks new liners, a little thicker than the first, were inserted, and gradually it became a part of the repair jobs necessary every Sunday to try liners of different sizes.

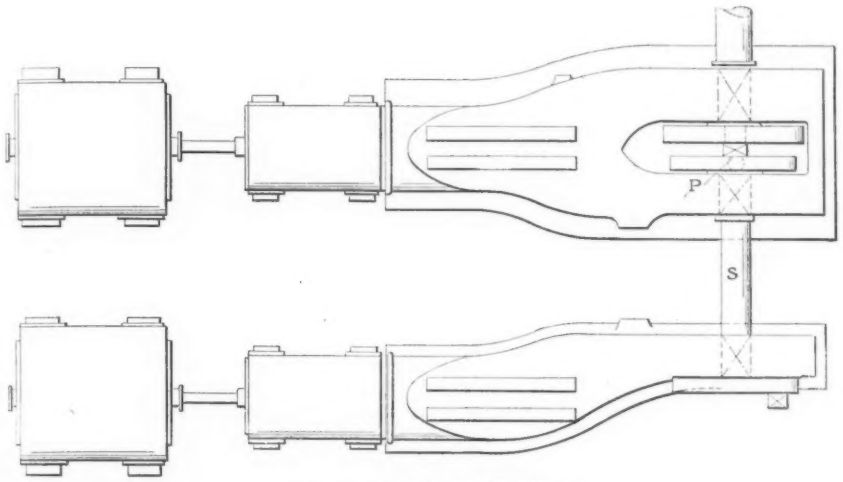


FIG. 1. PLAN VIEW OF ENGINE

With this arrangement it was necessary to insert the spherical pin in its brasses, put the brasses in place, attach the loose strips held by the tap bolts, and then lower the shafts into their bearings. In a very short time, the brasses became loose, causing the engine to make a nasty pound. In order to make any adjustment, it became necessary to take off the loose

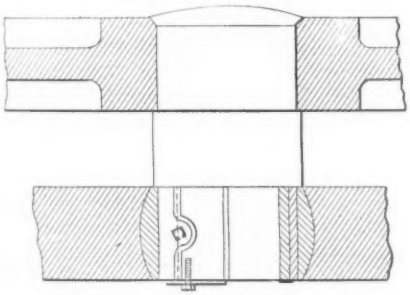
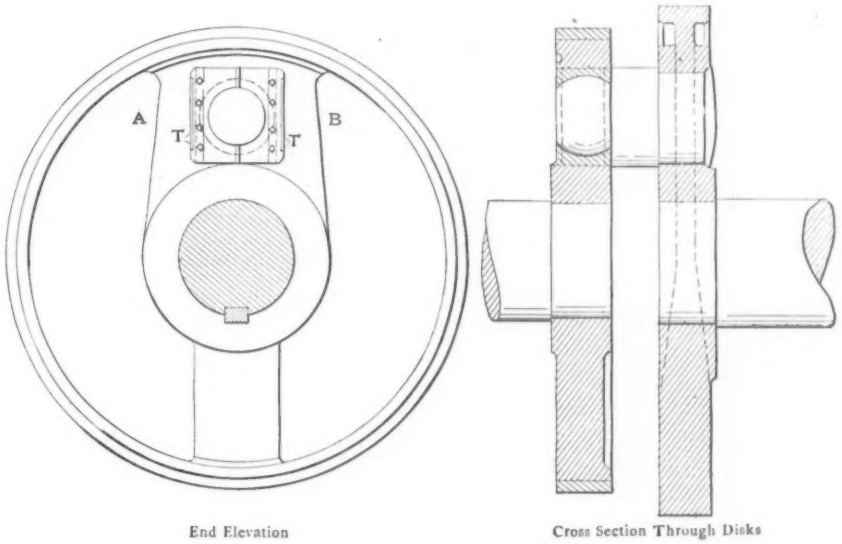


FIG. 3. PLAN AND SECTION AT C-D

Finally the brasses had to be replaced, and in order to remove the brasses it was necessary to jack up shaft *S*, Fig. 1. Soon it became a common thing to have to replace brasses, and as the engine room was not equipped with any crane, the jacking up of the shaft, in order to get out the brass boxes, became expensive and tedious.

The trouble was cured as follows: The square hole in the smaller disk was bored out as shown in the section *C D*, Fig. 3. The old crank pin was next removed and a new one made and riveted to the large disk, but turned straight for the small disk. Two new brasses were bored to suit, and were made with taper sides fitting against the wedges, as shown in Fig. 4. The wedges in turn rested against two shoes having one side turned to fit the bore of the crank hole. A collar on the crank pin held the brasses from coming out. When adjustment became necessary, the wedges were drawn down and the brasses made tight. It was no longer necessary to have a stock of planed liners

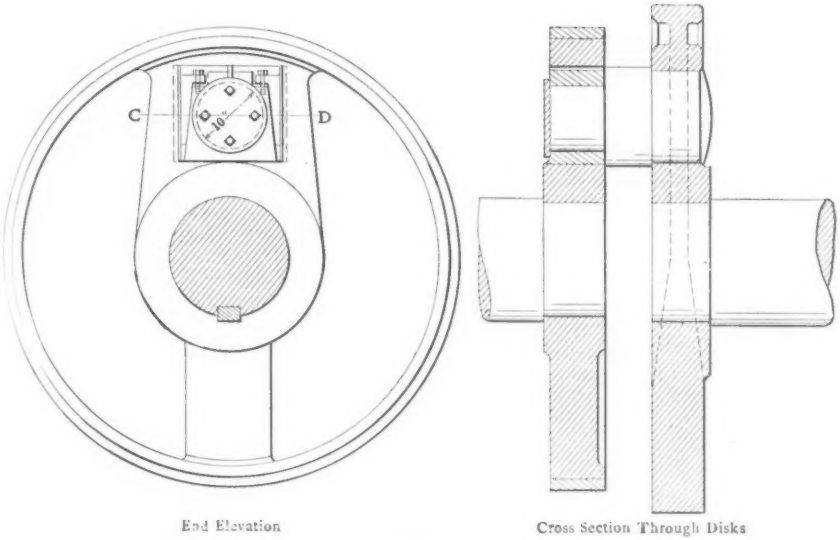


End Elevation

Cross Section Through Disks

FIG. 2

on hand, or to jack up the shaft when removing brasses, as with the new arrangement new brasses could easily be inserted and the shoes fitting in the bored hole of the crank disk still allowed a bad joint effect.



End Elevation

Cross Section Through Disks

FIG. 4

The problem of conveying crude oil in a pipe line has been solved in a peculiar manner in a line which has recently been laid from the Kern river oilfield to tidewater near Fort Costa, Cal. The oil is so thick and heavy that previous attempts at pipe transmission have been unsuccessful. It was proposed to put down a rifled pipe and to introduce water with the oil. The circular motion induced by the rifling throws the heavier fluid, the water, to the outside, making an annulus of water which flows along with its core of oil without undue friction.

The Strength of Riveted Joints*

Different Causes of Failure in Lap and Butt Joints; How to Find the Pitch, and to Estimate the Efficiency of Plate and Joint

BY J. W. RAUSCH

In joining two plates by what is known as the lap joint (see Fig. 1) it will be seen that a certain amount of metal is punched or drilled out in order to receive the rivets. The plate is therefore weakened to the extent that these holes bear to the solid sheet. The distance which these holes are apart is called the pitch and may be represented by the dotted lines. If, therefore, the diameter of the rivet hole equals one-half of the pitch, then the plate is reduced by one-half of its original strength, or 50 per cent.

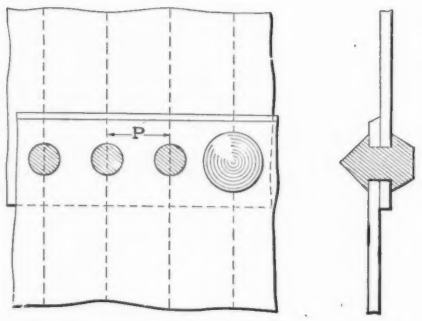


FIG. 1

In order to make this clearer, it will be assumed that the pitch is 2 inches, the rivet hole 1 inch, the thickness of plate ⅜ inch and the tensile strength of plate 60,000 pounds per square inch of section. The ultimate strength of the section of plate before punching or drilling represented by the pitch (see Fig. 2) will equal width times thickness times tensile strength, or

$$2 \times \tfrac{3}{8} \times 60{,}000 = 45{,}000$$

pounds.

Fig. 3 is a section of the plate represented by the pitch after drilling, and the ultimate strength equals:

$$1 \times \tfrac{3}{8} \times 60{,}000 = 22{,}500,$$

or one-half of its original strength.

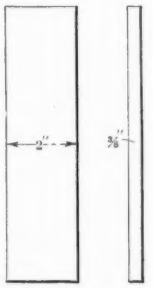


FIG. 2

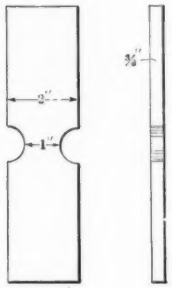


FIG. 3

From the above it will be seen that to find the efficiency of the plate, subtract the diameter of the rivet hole from the pitch and divide the remainder by the pitch. This may be expressed as follows:

$$\textit{Efficiency of plate} = \frac{\textit{pitch} - \textit{diameter of rivet hole}}{\textit{pitch}},$$

or

$$E = \frac{P - h}{P}.$$

The ultimate shearing strength of the rivet equals area of rivet times its shearing strength per square inch of section; in computing the shearing strength of the rivet the diameter of the rivet hole is taken. Assuming that a rivet after it has been driven is 1 inch in diameter and the shearing strength of the rivet is 40,000 pounds per square inch of section, then the ultimate strength of this rivet will be the diameter squared, times 0.7854, times 40,000, or

$$1 \times 1 \times 0.7854 \times 40{,}000 = 31{,}416$$

pounds.

A riveted joint may fail either by the sheet tearing apart, as is shown in Fig. 4, or by the rivets shearing as shown in Fig. 5, or by the plate in front of the rivet hole being crushed as shown in Fig. 6, or by shearing out the lap as shown in Fig. 7.

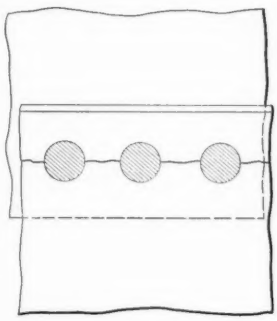


FIG. 4

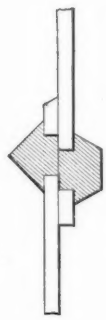


FIG. 5

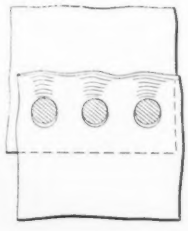


FIG. 6

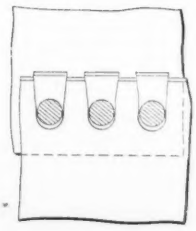


FIG. 7

A study of the sketches will make it clear that if the rivet is made larger it will gain in area and proportionately in strength, but at the expense of reducing the plate area and a proportionate weakening of the plate. On the other hand, if the rivet is made smaller, the plate area is increased, but at the expense of the rivet area; so that in order to secure the maximum strength the shearing strength of the rivets should equal the tensile strength of the plate between the rivet holes.

To find the correct pitch of a single-riveted seam: To find the correct pitch or distance which the rivets must be apart so that the shearing strength of the rivets will equal the tensile strength of the plate, multiply the area of the rivet hole by the shearing strength of the rivet and divide this product by the thickness of plate times its tensile strength, and to this quotient add the diameter of the rivet hole. This may be expressed as follows:

$$\textit{Pitch} = \frac{\textit{area} \times \textit{shearing strength of rivet}}{\textit{thickness of plate} \times \textit{tensile strength}} + \textit{rivet hole},$$

or

$$P = \frac{A\,S}{t\,T} + h.$$

EXAMPLE

What is the correct pitch of rivets if the plate is ⅜ inch thick and of 60,000 pounds tensile strength, the rivets ⅞ inch and rivet holes 15/16 inch; shearing strength of rivet 40,000?

$$\textit{Area of rivet} = \tfrac{15}{16} \times \tfrac{15}{16} \times 0.7854 = 0.6903;$$

$$\textit{Pitch} = \frac{0.6903 \times 40{,}000}{\frac{3}{8} \times 60{,}000} + \tfrac{15}{16} = 2\tfrac{3}{16}$$

nearly, or

0.6903
40,000
27,612.0600 strength of rivet: ⅜ × 60,000 = 22,500
22,500)27,612.0000(1.2272, or 1.23—, or 1¼ nearly
22,500
51,120
45,000
61,200
45,000
162,000
157,500
45,000
45,000

$1\frac{1}{4} + \frac{15}{16} = 2\frac{3}{16}$-*inch pitch.*

*Lecture by J. W. Rausch, superintendent inspection division, Maryland Casualty Company, delivered at an open meeting held under the auspices of Euclid Council No. 14, Universal Craftsmen Council of Engineers, Baltimore, October 29, 1908.

It will be noticed that 27,612 ÷ 22,500 = 1.23. This is only two one-hundredths less than 1¼, so that in practice 1¼ would be taken, and by adding 15/16 inch, the diameter of the rivet hole, we have $2\frac{3}{16}$ inches as the pitch; but in practice it is well to space the rivets in a single-riveted lap joint a little farther apart, because in constructing the seam everything tends to make the rivet larger and reduce the plate area. For instance, if the plate is punched, the punch for a ⅞-inch rivet would be 15/16 and the die would be 1 inch, so that the hole in the plate would be tapered; that is to say, it would be 15/16 inch on one side and 1 inch on the other; also, reaming is very often necessary, which increases the rivet area at the expense of the plate area.

The ultimate strength of a seam will depend upon its weakest part, the same as the strength of a chain will depend upon its weakest link; so that the efficiency of the seam will depend upon the strength of its weakest part as compared to the solid sheet. From this it will be seen that to find the efficiency we must first find the efficiency of the plate; second, the efficiency of the rivets, and third, the resistance to crushing as compared to the solid plate, and the weakest of the three should be taken.

Crushing

It has been found by experiment that the crushing strength in front of the rivets is high and irregular, and, according to the best authorities, in some of the tests the crushing strength was as high as 150,000 pounds per square inch of section, while in a few tests it was less than 85,000 pounds; so that 90,000 pounds will probably be safe in calculating riveted joints. The usual method adopted in calculating the crushing strength is to multiply the diameter of the rivet hole by the thickness of the plate, then multiply this product by the crushing strength.

Lap

In practice a sufficient lap can always be made so that a joint never fails by shearing out as shown in Fig. 7. The distance from the center of the rivet to the edge of the lap is usually one and a half times the diameter of the rivet hole. This appears to give an ample margin of safety and is also satisfactory for calking.

Example

What is the efficiency of a single-riveted lap joint of the following dimensions: Shell plates, ⅜ inch thick; strength of plates, 60,000 pounds per square inch of section; rivets, ⅞ inch; shearing strength of rivets, 40,000 pounds per square inch of section; rivet holes, 15/16 inch; pitch of rivets, 2 3/16 inch; crushing strength, 90,000 pounds per square inch of section.

In a former example we found that the efficiency of plate equals

$$\frac{P - h}{P},$$

or

$$\frac{2\frac{3}{16} - \frac{15}{16}}{2\frac{3}{16}} = \frac{\frac{35}{16} - \frac{15}{16}}{\frac{35}{16}} = \frac{\frac{20}{16}}{\frac{35}{16}} = \frac{20}{16} \times \frac{16}{35} = \frac{20}{35} = 0.57$$

or 57 per cent. for the plate.

To find the efficiency of rivets, multiply the area of the rivet hole by the shearing strength of the rivet and divide this product by the pitch times the thickness

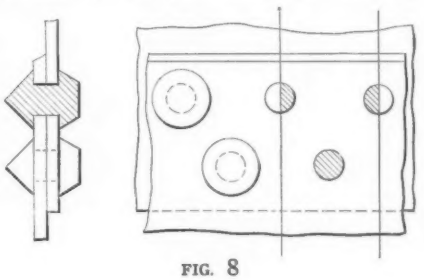


FIG. 8

of plate times the tensile strength of plate.

This may be expressed as follows:

$$\text{Efficiency} = \frac{\text{area} \times \text{shearing strength of rivet}}{\text{pitch} \times \text{thickness of plate} \times \text{tensile strength}},$$

or

$$\frac{0.6903 \times 40{,}000}{2\frac{3}{16} \times \frac{3}{8} \times 60{,}000} = \frac{27{,}612}{49{,}218.75} = 0.56,$$

or 56 per cent. for the rivets.

The resistance to crushing as compared to the solid sheet equals

$$\frac{h\,t\,C}{P\,t\,T} = \frac{\text{diameter of rivet hole} \times \text{thickness of plate} \times \text{crushing strength}}{\text{pitch} \times \text{thickness of plate} \times \text{tensile strength}} =$$

$$\frac{1\frac{15}{16} \times \frac{3}{8} \times 90{,}000}{2\frac{3}{16} \times \frac{3}{8} \times 60{,}000} = \frac{31{,}640.625}{49{,}218.75} = 64$$

per cent.

It will be noticed that the resistance to crushing is in excess of the strength of the plate and the rivets. It will also be noticed that the efficiency of the rivets is 1 per cent. less than the efficiency of the plate. Also, in referring to the calculation wherein the correct pitch was de-

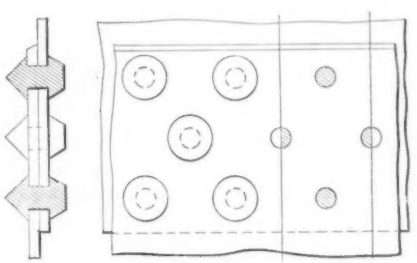


FIG. 9

termined, it will be found that the pitch should have been $\frac{2}{100}$ of an inch less than $2\frac{3}{16}$ inches, which accounts for the difference of the 1 per cent.

DOUBLE- AND TRIPLE-RIVETED LAP JOINTS

A lap-riveted joint may be made stronger if instead of using one row of rivets two or more rows are used. Fig. 8 represents what is known as the double-staggered riveted lap joint. In comparing this joint with the single-riveted joint it will be noticed that instead of there being one rivet in each pitch there are two, making the shearing strength of the rivets in each pitch proportionately stronger. In this way the pitch may be increased, thus gaining a greater efficiency. There is, however, a limit to the spacing of the rivets, for the reason that if the rivets were spaced too far apart the lap of the seam could not be kept tight.

Fig. 9 shows the construction of a triple-riveted lap joint. In this construction the joint may be made stronger by increasing the pitch, or by using smaller rivets. The shearing strength of the rivets is taken care of by the additional rivet in each pitch. In computing the strength, or in determining the correct pitch of a double- or triple-riveted lap joint, the same principle applies as for the single-riveted joint; that is to say, the method is exactly the same only the number of rows of rivets must be taken into consideration.

To find the correct pitch of a double- or triple-riveted lap joint so that the shearing strength of the rivets will equal the tensile strength of the plate, multiply the area of the rivet hole by the number of rows of rivets, then multiply this product by the shearing strength of the rivets, and divide the result by the thickness of the plate times its tensile strength, and to this quotient add the diameter of the rivet hole. This may be expressed as follows:

$$P = \frac{A\,N\,S}{t\,T} + h,$$

where

P = Pitch of rivets,
h = Diameter of rivet hole,
A = Area of rivet hole,
N = Number of rows of rivets,
S = Shearing strength of rivets,
t = Thickness of plate,
T = Tensile strength of plate.

Example

What is the correct pitch of the rivets of a double-riveted lap joint where the plate is of steel ⅜ inch thick and of 55,000 pounds tensile strength, rivets ⅞ inch in diameter of 40,000 pounds shearing strength, rivet holes 15/16 inch in diameter?

According to the foregoing formula

$$\text{Pitch} = \frac{0.6903 \times 2 \times 40{,}000}{\frac{3}{8} \times 55{,}000} + 1\frac{15}{16} = 3.615$$

$$\frac{3}{8} = 0.375$$
$$55{,}000$$
$$1{,}875{,}000$$
$$1{,}875$$
$$20{,}625.000$$

$$\text{Diameter } 1\frac{15}{16} = 0.9375$$
$$2.6775$$
$$3.6150$$

Area of $1\frac{15}{16} = 0.6903$

$$
\begin{array}{r}
2 \\
\hline
1.3806 \\
40{,}000 \\
\hline
20{,}625)\ 55{,}224.0000\ (2.6775 \\
41{,}250 \\
\hline
139{,}740 \\
123{,}750 \\
\hline
159{,}900 \\
144{,}375 \\
\hline
155{,}250 \\
144{,}375 \\
\hline
108{,}750 \\
103{,}125 \\
\hline
5{,}625
\end{array}
$$

It will be seen that theoretically the correct pitch so far as it relates to the shearing strength of the rivets and the tensile strength of the plate is 3.615 inches, but in practice this pitch would, in all probability, be too great to insure a tight joint.

The correctness of the foregoing example may be proven by calculating the efficiency of the plate and the rivets.

To find the efficiency of the plate of a double- or triple-riveted lap joint, subtract the diameter of the rivet hole from the pitch and divide the remainder by the pitch.

To find the efficiency of the rivets of a double- or triple-riveted joint, multiply the area of the rivet hole by the number of rows of rivets and multiply this product by the shearing strength of the rivets; then divide this result by the pitch times the thickness of plate times the tensile strength of the plate.

According to the foregoing example, we have the following:

Efficiency of plate =

$$\frac{P-h}{P} = \frac{3.615-0.9375}{3.615} = \frac{2.6775}{3.615} = 74$$

per cent.

Efficiency of rivets =

$$\frac{A\,N\,S}{P\,t\,T} = \frac{0.6903\times 2\times 40{,}000}{3.615\times 0.375\times 55{,}000} = \frac{55{,}224}{74{,}559.375} = 74$$

per cent.

The resistance to crushing is usually in excess of the strength of the plate and rivets, and in this case the efficiency as to crushing equals

$$\frac{2\,h\,t\,C}{P\,t\,T} = \frac{2\times 0.9375\times 0.375\times 90{,}000}{3.615\times 0.375\times 55{,}000} = 84$$

per cent.

BUTT JOINTS

Double-riveted Butt Joints

Fig. 10 illustrates the construction of a double-riveted butt joint. There are two rows of rivets on each side of the joint. The rivets in the inner rows are in double shear and the rivets in the outer rows are in single shear. There are three rivets in each pitch; one in the outer row which is in single shear, and two in the inner row which are in double shear. If this joint were to fail by the rivets shearing, then the rivets in the inner row would have to shear in two places; so that for each pitch five sections of rivets would have to be sheared. In practice it is not customary to allow twice the shearing resistance for rivets in double shear. Usually 1.75 times single shear is allowed for double shear.

There are five ways in which this joint may fail, and to determine the efficiency the strength of each part may be calculated separately, and then the strength of the weakest part divided by the strength of the solid plate.

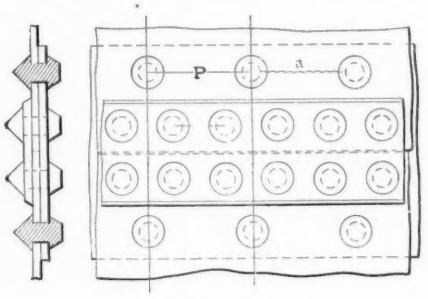


FIG. 10

Example

What is the efficiency of a double-riveted butt joint of the following dimensions: Thickness of plate, 7/16 inch; thickness of covering plates, 7/16 inch; diameter of rivets, ⅞ inch; diameter of rivet holes, 15/16 inch; pitch of outer row of rivets, 5¼ inches; pitch of inner row of rivets, 2⅝ inches; tensile strength of plate, 55,000 pounds; shearing strength of rivets (mild steel), 45,000 pounds; crushing strength, 90,000 pounds.

Calculating the resistance of each part separately the joint may fail:

First—At the outer row of rivets. The resistance is

$$(P-h)\ t\ T = (5\tfrac{1}{4} - 1\tfrac{15}{16}) \times \tfrac{7}{16} \times 55{,}000 = 103{,}769.$$

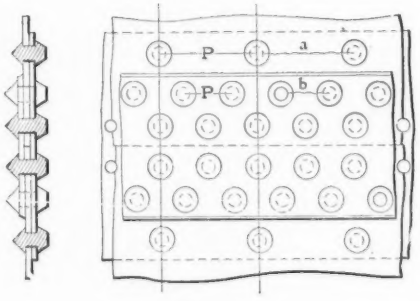


FIG. 11

Second—By tearing apart at the inner row of rivets and shearing one of the rivets in the outer row. The resistance is

$$(P-2\,h)\ t\ T + A\ S =$$
$$(5\tfrac{1}{4} - 2\times 1\tfrac{15}{16}) \times \tfrac{7}{16} \times 55{,}000 +$$
$$0.6903 \times 45{,}000 = 112{,}274.$$

Third—By shearing two rivets in double shear and one rivet in single shear. Allowing 1.75 times single shear for double shear, the resistance is

$$2\ A\ S\ 1.75 + A\ S =$$
$$2 \times 0.6903 \times 45{,}000 \times 1.75 +$$
$$0.6903 \times 45{,}000 = 139{,}785.$$

Fourth—By crushing in front of two rivets and shearing one rivet. The resistance is

$$2\,h\,t\,C + A\,S =$$
$$2 \times 1\tfrac{15}{16} \times \tfrac{7}{16} \times 90{,}000 + 0.6903 \times$$
$$45{,}000 = 104{,}891.$$

Fifth—By crushing in front of three rivets. The resistance is

$$3\,h\,t\,C =$$
$$3 \times 1\tfrac{15}{16} \times \tfrac{7}{16} \times 90{,}000 = 110{,}742.$$

The resistance of a piece of plate equal to the width of the pitch at the outer row of rivets equals

$$5\tfrac{1}{4}\ t\ T = 5\tfrac{1}{4} \times \tfrac{7}{16} \times 55{,}000 = 126{,}328.$$

The least resistance being at the outer row of rivets (see *a*, Fig. 10), the efficiency equals

$$\frac{103{,}769}{126{,}328} = 82$$

per cent.

Triple-riveted Butt Joints

Fig. 11 illustrates the construction of a triple-riveted butt joint. There are three rows of rivets in each side of the joint. The rivets in the inner rows are in double shear and the rivets in the outer rows are in single shear. There are five rivets in each pitch; four of them are in the inner rows and are in double shear, and one is in the outer row and is in single shear. So that if this joint were to fail by the rivets shearing, nine sections of rivets in each pitch would have to be sheared.

Example

What is the efficiency of a triple-riveted butt joint of the following dimensions: Thickness of plate 7/16 inch = t; thickness of covering plates, ⅜ inch = t'; diameter of rivets, ⅞ inch; diameter of rivet holes, 15/16 inch; pitch of outer row of rivets, 6¾ inches; pitch of inner row of rivets, 3⅜ inches; tensile strength of plate, 55,000 pounds; shearing strength of rivets (iron), 38,000 pounds; crushing strength, 90,000 pounds.

There are five ways in which this joint may fail. Calculating the resistance of each part separately, the joint may fail:

First—At the outer row of rivets. The resistance is

$$(P-h)\ t\ T =$$
$$(6\tfrac{3}{4} - 1\tfrac{15}{16}) \times \tfrac{7}{16} \times 55{,}000 = 139{,}863.$$

Second—By tearing apart at the middle

row of rivets (see *b*, Fig. 11) and shearing one rivet in the outer row. The resistance is

$$(P - 2\,h)\,t\,T + A\,S =$$
$$(6\tfrac{3}{4} - 2 \times \tfrac{15}{16}) \times \tfrac{7}{16} \times 55{,}000 +$$
$$0.6903 \times 38{,}000 = 143{,}536.$$

Third—By shearing four rivets in double shear and one rivet in single shear, allowing 1.75 times single shear for double shear. The resistance is

$$4\,A\,S\,1.75 + A\,S =$$
$$4 \times 0.6903 \times 38{,}000 \times 1.75 +$$
$$0.6903 \times 38{,}000 = 209{,}851.$$

Fourth—By crushing in front of four rivets and shearing one rivet. The resistance is

$$4\,h\,t\,C + A\,S =$$
$$4 \times \tfrac{15}{16} \times \tfrac{7}{16} \times 90{,}000 + 6903 \times$$
$$38{,}000 = 173{,}887.$$

Fifth—By crushing five rivets. As the covering plates are thinner than the shell plate, and as one of these rivets passes through one of the covering plates only, the crushing resistance of one rivet must be taken at the thinner plate. The resistance is

$$4\,h\,t\,C + h\,t'\,C =$$
$$4 \times \tfrac{15}{16} \times \tfrac{7}{16} \times 90{,}000 + \tfrac{15}{16} \times \tfrac{3}{8} \times$$
$$90{,}000 = 179{,}297.$$

The resistance of a piece of plate equal to the width of the pitch at the outer row of rivets equals

$$6\tfrac{3}{4}\,t\,T = 6\tfrac{3}{4} \times \tfrac{7}{16} \times 55{,}000 =$$
$$162{,}422.$$

The least resistance being at the outer row of rivets (see *a*, Fig. 11) the efficiency equals

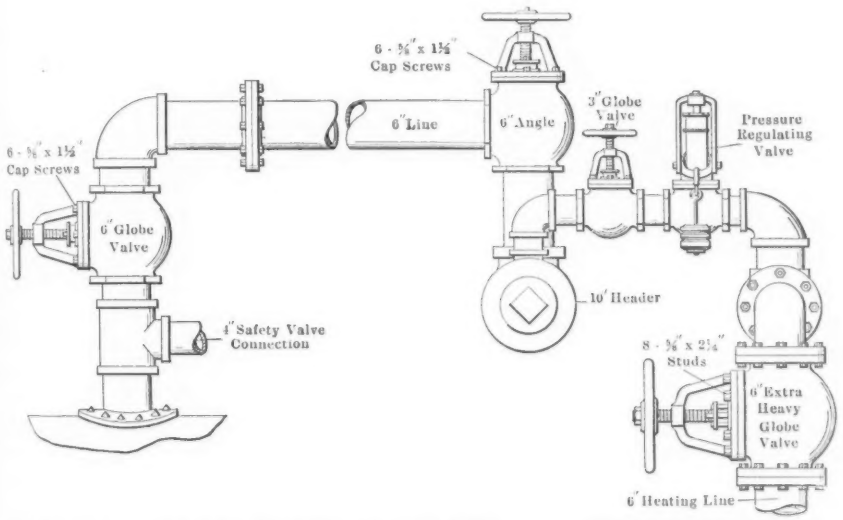
$$\frac{139.863}{162{,}422} = 86$$

per cent.

Selection and Safety of Pipe Fittings

By A. J. Dixon

In steam plants where a miscellaneous assortment of valves and fittings are available for use in pipe lines, one may very frequently run across ludicrous examples of incongruity in the arrangement of fittings for particular purposes, as for instance the use of standard cast-iron fittings in the drain pipe from a main steam line under 75 pounds pressure, to a trap, and then the use of hydraulic fittings tested to a pressure of 2000 pounds per square inch, in piping the discharge from the trap to a receiver. Of course, in this case the element of safety suffers no appreciable deterioration, for the standard fittings are ample and appropriate for the purpose to which they are put, although it would seem that when a choice exists between two sets of fittings widely differing in point of strength, a proper appreciation of the fitness of things would suggest placing the stronger fittings where the pressures are highest.



ARRANGEMENT OF VALVES AND FITTINGS IN HORIZONTAL RETURN TUBULAR BOILER PLANT

On the other hand, however, when it becomes a matter of choosing between standard and low-pressure valves and fittings in plants where boiler pressures of from 75 to 100 pounds, and low heating pressures of 5 to 10 pounds are required, the element of safety certainly does suffer if the steamfitter picks his fittings at random without any regard to relative strength, and reverses the correct order of things by putting the standard fittings in the low-pressure heating lines and using the relatively weak low-pressure fittings where they will be subjected to standard boiler pressures. The arrangement of valves and piping shown in the accompanying sketch may be taken as an illustration.

The plant to which this apparatus pertains, consists of two horizontal return-tubular boilers, each having the equipment of valves and fittings shown and carrying a pressure of 75 pounds per square inch. The 6-inch globe valve shown in the heating line is a new standard Crane valve adapted to a working pressure of 100 pounds per square inch, while the regulating valve is set to reduce the pressure in this line to 5 pounds. The 6-inch globe valve in the riser from the boiler and the 6-inch angle valve at the juncture of the horizontal lead with the main header are both second-hand and are of very ancient and uncertain origin. The general appearance of these valves, when considered in comparison with the substantial and solid-looking standard valve in the heating line, conveys an impression of frailty and insecurity entirely inconsistent with their use in connection with standard boiler pressures. However, the metal section in the body of each of these valves and the quality of the iron might give, and probably would give a factor of safety high enough to make them amply safe against a steam pressure of 75 pounds per square inch, were it not for the manner of securing the bonnet to the body of the valve. This was done with six ⅝x1½-inch cap screws, whereas in the case of the standard valve in the heating line the bonnet is held on with eight ⅝x2¼-inch studs.

After the plant had been in operation about a month the engineer in charge decided to remove the bonnets of the valves in question for an inspection of the disks and seats, and upon replacing the bonnets, new gaskets of a rubber composition ⅛ inch thick were used. While getting up steam after the completion of the job the bonnet joint in the angle valve began to leak, and attempting to stop the leak by taking up on the cap screws only made the leak worse. It soon became evident to the engineer that it was only a matter of a little more time and a little higher steam pressure to send the bonnet skyward, so the valve was cut out by closing the globe valve in the riser, the companion boiler being dead. The bonnet was removed and a thinner gasket and new cap screws were put in, making it possible to operate the plant. To make sure of the job a temporary rigging for clamping the bonnet to the body of the valve was devised, and it was the intention that it should serve as a measure of precaution against possible disaster until time would be available for making permanent repairs.

A few days subsequent to the event just related, an opportunity to fix up the defective valve presented itself, and so the bonnet was again removed and the ⅝-inch screw holes were drilled and tapped for ¾x2-inch studs. While doing this work an examination of the original ⅝-inch holes revealed a worn condition of the threads, and a consequent loose fit of the cap screws, with the threads likewise worn. This condition was undoubtedly

brought about by numerous removals of the bonnet, with the attendant alternate slackening and tightening of the screws during the many years the valve was in service, and might also to a considerable extent have been due to the stress brought upon the screws by jamming the disk against the seat in the frequent closures of the valve. At any rate, whatever the cause may have been, the imperfect fit of the screws had reduced an originally adequate factor of safety for standard pressures, given by this method of securing the valve bonnet when the work was new and the screw tight, to very nearly zero, as was evidenced by the leaky condition of the joint, and its refusal to tighten up. What the original factor of safety was, may be shown by the following figures:

The opening covered by the bonnet flange is in this case 7¼ inches in diameter, hence the area exposed to the pressure of the steam is

$$(7\tfrac{1}{4})^2 \times 0.7854 = 41.28$$

square inches; and so, with a boiler pressure of 77 pounds per square inch—at which point the safety valve blows—the total pressure to be resisted by the cap screws is

$$41.28 \times 77 = 3178.56$$

pounds. Since there are six screws to resist this pressure, the stress in each is

$$\frac{3178.56}{6} = 529.76$$

pounds. Besides the stress due to the internal pressure on the flange, another factor must also be taken into account in this and similar cases, and that is the tension set up in the screws in tightening them down and clamping the gasket in place against the internal pressure. Evidently, the intensity of this stress can only be taken approximately, for we can have no accurate knowledge of the amount of energy applied at the screw heads, this being a matter of individual discretion in making up the joint. However, in the present case we may accept 50 pounds per square inch as a conservative estimate of the pressure applied to the gasket in making it tight against the steam pressure.

So, with a bonnet flange 11 inches in diameter, the area exposed to this pressure is

$$11^2 \times 0.7854 - 41.28 = 53.75$$

square inches; therefore, the total pressure on the gasket is

$$53.75 \times 50 = 2687.5$$

pounds, and the tension from this source on each screw is

$$\frac{2687.5}{6} = 447.92$$

pounds. Adding this to the stress caused by the internal pressure, we have as the total tensile stress in each screw

$$529.76 + 447.92 = 977.68$$

pounds.

In regard to the cap screws, it is clear that failure of the bonnet joint may result from either of two causes: the screws may be torn apart by reason of the tensile stress on them, or the threads may be stripped and pull out of the holes in the body of the valve by virtue of the shearing stress exerted upon the bolts. From the manner in which the weakness of the joint was manifested, we may reasonably accept a diminished margin of safety against shear as the cause of failure in this case without comparing the stresses mathematically.

In obtaining the original shearing strength of the joint, it is evident that with a combined thickness of flange and gasket of ⅞ inch, and the length of the screws 1½ inches, the depth to which each screw enters is ⅝ inch. The lateral area of a cylinder ⅝ inch in diameter and ⅝ inch long is

$$\tfrac{5}{8} \times 3.1416 \times \tfrac{5}{8} = 1.227$$

square inches. The pitch of a standard ⅝-inch screw thread is 1/11 inch; hence in this case the number of convolutions, or turns of the thread in actual contact is

$$11 \times \tfrac{5}{8} = 6.875.$$

The space between adjacent convolutions at the root of the thread is 0.0113 inch wide; hence in the total length of thread contact, the area of this space is approximately

$$\tfrac{5}{8} \times 3.1416 \times 0.0113 \times 6.875 = 0.153$$

square inch, and consequently the area of metal in the cast-iron valve body resisting the shearing action of each wrought-iron screw thread is

$$1.227 - 0.153 = 1.074$$

square inches. Accepting 20,000 pounds per square inch as the ultimate shearing strength of cast iron, the capacity of the above area to resist shear is

$$1.074 \times 20{,}000 = 21{,}480$$

pounds. Therefore, on the assumption of an absolutely perfect metal-to-metal fit for each of the six cap screws, the factor of safety is

$$\frac{21{,}480}{977.68} = 21.97.$$

This safety factor, considered in the light of good engineering practice, is amply sufficient for the purpose. As a matter of fact, it is considerably higher than the margin of safety against rupture by tension in the screws themselves, which margin of safety, by the way, is rather deficient than otherwise when measured by the rules of good design. But it is evolved on the supposition that the threads interlock and fit each other with absolute accuracy from end to end, giving continuous metal contact and practically making the screw and valve body one continuous mass of metal. A permanently perfect fit of this kind can only be accomplished by the use of studs; for it is clearly apparent that where cap screws are employed for the purpose, their fit in the holes is bound to become more or less impaired through wear and distortion of the threads by friction and through the corrosive effects of oils. As in the case in hand, this looseness of fit and attendant impairment of strength may continue to increase until an entirely adequate factor of safety in the first place reduces to almost nothing.

The Slipping Point of Rolled Boiler Tube Joints

Profs. O. P. Hood and G. L. Christensen, of Houghton, Mich., presented the results of tests made to determine the slipping point of rolled boiler-tube joints, made with the idea that the failure of the joint arises when it slips sufficiently to induce leakage and not when it actually pulls out; that the point of slippage bears, as it were, the same relation to the point of absolute failure that the limit of elasticity does to the breaking point. A 3-inch 12-gage Shelby cold-drawn tube expanded into a straight-machined hole in a 1-inch plate, the tube ends projecting ½ inch and not flanged, began to move under a stress of 9000 pounds, showed a decided slip at 12,000 pounds and reached an ultimate holding strength of 18,000 pounds, the slip occurring at 50 per cent. of the ultimate holding strength and 29 per cent. of the elastic limit of the material in the tube.

A 3-inch tube under 225 pounds pressure will be urged from its seat by a force of about 1600 pounds due to pressure alone. In many cases the initial slip comes in at about 6000 pounds. This gives a factor of safety of 3.75 within the slipping point to take care of the unknown temperature stresses. If the design calls on a tube to act as a stay and support the pressure of but 16 square inches, this factor of safety within the slipping point is reduced to about 1.7. Harder rolling, within certain limits, will raise the ultimate holding power, but has little effect on the initial slip. Flaring the projecting end of the tube raises the ultimate holding power, but does not alter the original slipping point.

Numerous forms of single- and double-tapered joints were tested, and it was found that grooving the tube sheets in a straight-machined hole, by rolling or cutting square-edged grooves about 0.01 of an inch deep and 10 pitch, will raise the slipping point to three or four times that in a smooth hole, and that it is possible to make a rolled joint that will offer a resistance beyond that of the elastic limit of the tube and remain tight.

An Interesting Condenser Action

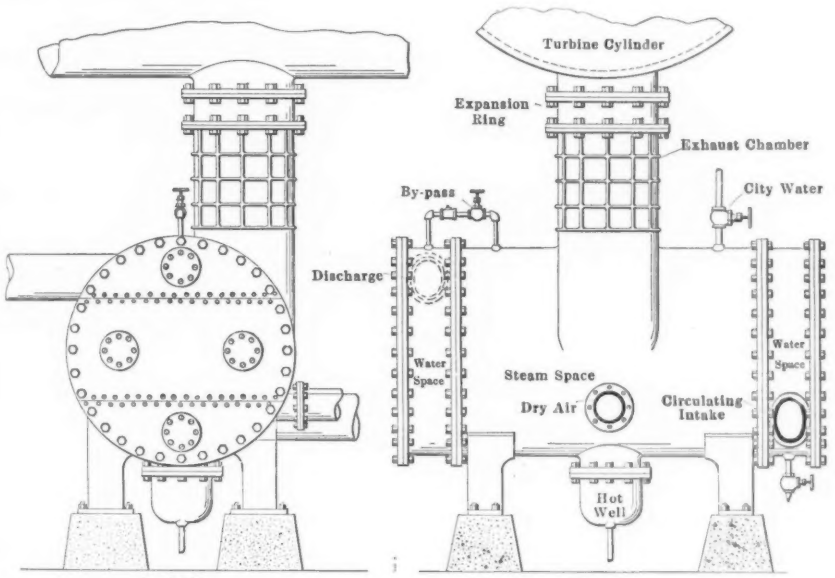
By Edwin T. Binns

Some incidental experiences with the surface condenser of a 6000-kilowatt steam turbine may be interesting. The condenser contains 4779 one-inch brass tubes, giving a cooling capacity of 2000 square feet, and it weighs 30,528 pounds. The exhaust opening from the turbine into the condenser is 7 feet 9 inches by 3 feet 10 inches. Attached to this condenser is an 18-inch centrifugal circulating pump, steam-engine driven, which has a capacity of 20,000 gallons of cooling water in twenty-four hours.

The water, entering near the bottom and at the side of one end, passes through the lower section, returns through the middle section, and passes to the discharge pipe at the top and at the end and much to raise water as to keep it in motion through the tubes.

An Ingenious Device

To provide against the danger of losing the cooling water while the condenser is in operation a rather ingenious device was resorted to. I have called it a siphon, but in reality it is not, as it is not possible to discharge the water at a lower point than the mouth of the intake; otherwise the water would run perpetually through the condenser by gravitation. In order, however, to partake of all the benefits of the weight of the water in the discharge pipe it was necessary to make careful provision against the accumulation of air in the top. Two holes were accordingly drilled and tapped for a ½-inch pipe, one in the highest part of the water space, the other in the steam space. The two spaces were then connected together. In this pipe line were placed a globe valve



INTERESTING CONDENSER INSTALLATION

side opposite the starting point. The circulating water is taken from a large fresh-water supply and conveyed to the station in unstinted quantities. Several screens are provided and every possible precaution taken to guard against the accumulation of foreign matter in the tubes, such a condition being generally indicated by low vacuum.

An ejector is connected to the highest point in this space, which includes all the interior area of the tubes and the space between the tube ends and the condenser heads. The mission of the ejector is to expel the air from the empty water space before starting. Thus by creating a partial vacuum the water rushes in. When this is accomplished we might say the water is "on a balance," the weight of that in the discharge or tail pipe being the same as that in the intake line where the circulating pump is located, so that when the pump is started its duty is not so and a check valve, the latter being set so as to allow for the passage of air in the direction of the steam space only, in which space a vacuum of about 28 inches was usually maintained.

Thus by opening the globe valve, a slight turn usually being sufficient, the air was easily extracted and kept out after the dry-vacuum pump was started. It was not desirable to have much water drawn through this line, as it only made extra duty for the hot-well pump, besides being likely to clog the apparatus by washing floating substances into it from the circulating water.

The hot-well pump is a two-phase turbine pump driven by a 20-horsepower motor. It takes care of the water of condensation, returning it to the feed-water heater for boiler use, the additional percentage needed for boiler consumption being added in the heaters by makeup pumps provided for the purpose and receiving their supply from the discharge conduit from the condenser.

A Puzzling Experience

An interesting and at first somewhat puzzling experience was passed through in the early history of the installation, of which this condenser and its equipment form about one-eighth. There is a flexible expansion ring in the connection between the solid cylinder of the turbine and the top of the exhaust chamber on top of the condenser. This is to allow for the expansion and contraction of the metal due to variations in temperature. At times, when the vacuum was very high, there appeared a vibration on the foundation as though the big 40-ton condenser was not heavy enough to rest on its foundations. It was virtually anchored down by especially prepared stays. When we consider that 28 inches of vacuum means more than 14 pounds atmospheric pressure per square inch, and that the area of the exhaust chamber was 3114 square inches, it is evident that there would be an upward pressure of 43,596 pounds, or 21.79 tons. The exhaust chamber is located on one side of the top so that as the total weight was 40 tons, one-half of this weight would be insufficient to counteract the atmospheric pressure. The amount of vertical movement was, of course, very small, as the expansion ring would only permit of about 1/16 inch of variation.

Detecting Leaks

Loose tubes, leaks, etc., are found by emptying the water space, and filling the steam space with water. Then by removing some of the manhole plates and inserting a light, the leak will manifest itself. In case of any disablement of the circulating equipment, both steam and water spaces are filled with cold water up to the bottom of the exhaust chamber and the turbine run at high pressure or noncondensing, the atmospheric valve being left open. The usual course in starting up is to put the ejector on first, and get water up, which is shown by gage glasses and combination vacuum and pressure gages on the intake and discharge pipes. The circulating-pump engine is then started so as to keep the tubes cool from the first, when the exhaust steam begins to strike them. The vacuum-pump engine is then started and the vacuum breakers closed.

When sufficient water of condensation appears in the hot-well overflow line, this valve is closed and the hot-well pump started. The turbine being brought up to speed, the atmospheric valve is closed and the vacuum begins gradually to rise, it generally taking about ten minutes to rise to and keep it steady at 28 inches. A recording gage shows the hight of the vacuum at all hours and these records are preserved for reference.

Power Plant of St. Luke's Hospital, Chicago

A Plant Containing Special Heating and Ventilating Features and a Complete Line of Apparatus Designed to Facilitate Hospital Work

BY OSBORN MONNETT

At Chicago the new $600,000 addition to the St. Lukes hospital, known as the "George Smith Memorial," and made possible through the gift of the late James Henry (Silent) Smith, was recently dedicated. The addition, which has been declared by physicians to be the most admirably equipped hospital in the city, fronts on Michigan avenue between Fourteenth and Fifteenth streets, is 6½ stories in hight, of the renaissance style of architecture and offers a new and imposing entrance to the group of hospital buildings.

In addition to being fireproof, with steel stairways, etc., the building is practically sound and dustproof through the use of double doors and windows throughout. It will be operated in conjunction with the older buildings which front on Indiana avenue, but will be given over almost entirely to private rooms, of which there are over 100, with the necessary operating, equipment and dressing rooms, kitchens, etc. As might be expected, the mechanical plant contains much in the way of apparatus to facilitate the work of the hospital, and is a good example of the extent to which the services of the stationary engineer are called upon in the conduct of a modern institution of this kind.

The power plant, which is shown in plan and elevation in Fig. 1, is located on the basement-floor level and is surmounted by a one-story structure so constructed as to form open courts over the boiler, pump and engine rooms, in which are skylights admitting ample light to the space below.

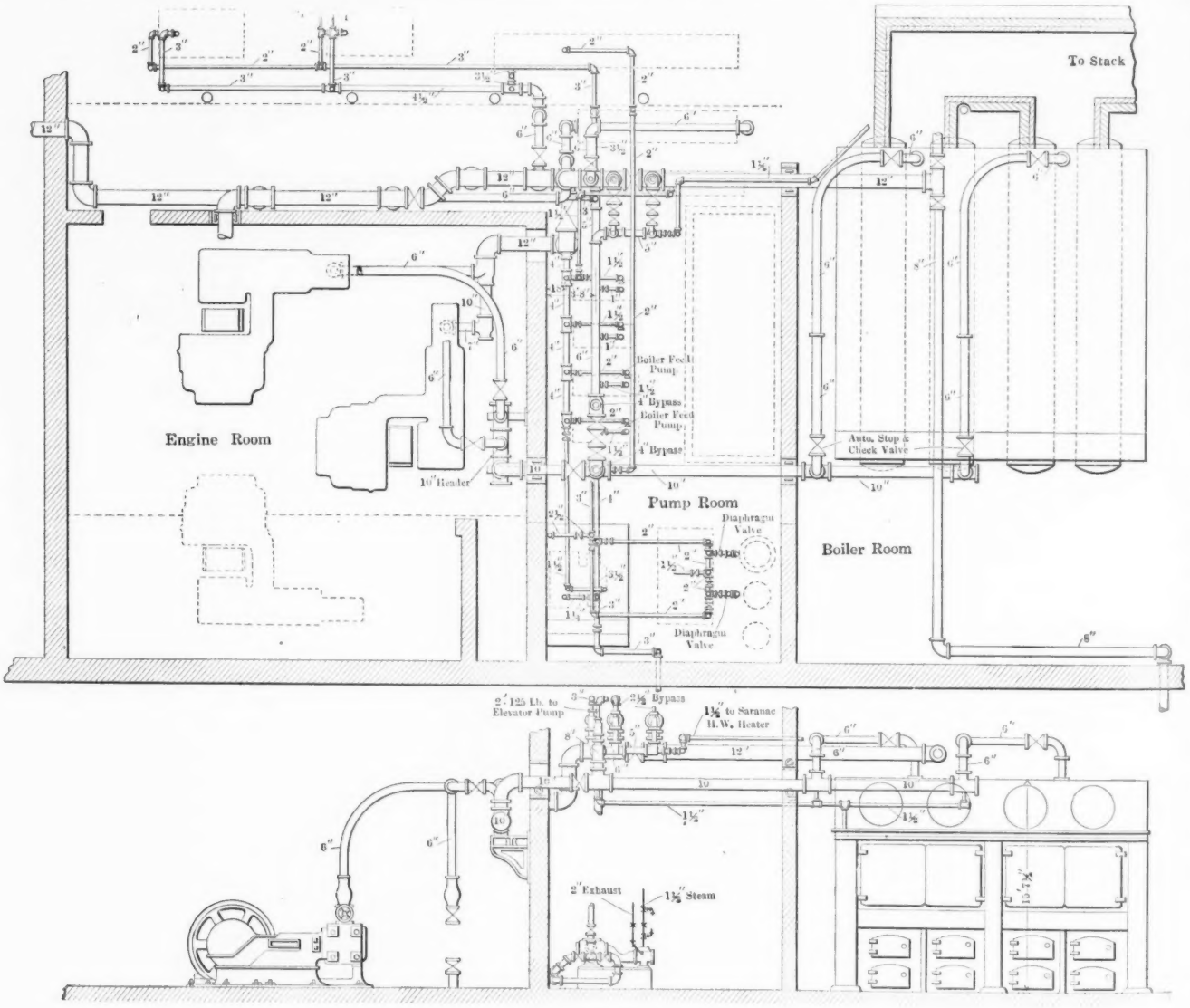


FIG. 1. PLAN AND ELEVATION OF POWER PLANT

Boiler Room

Coal is delivered from the alley at the rear of the buildings direct to the boiler-room floor, whence it is fed to the

furnaces by hand. Two Edge Moor water-tube boilers are installed, each rated at 280 horsepower and containing 2810 square feet of heating surface in 135 4-inch Shelby cold-drawn seamless steel tubes. The boilers have wrought-steel

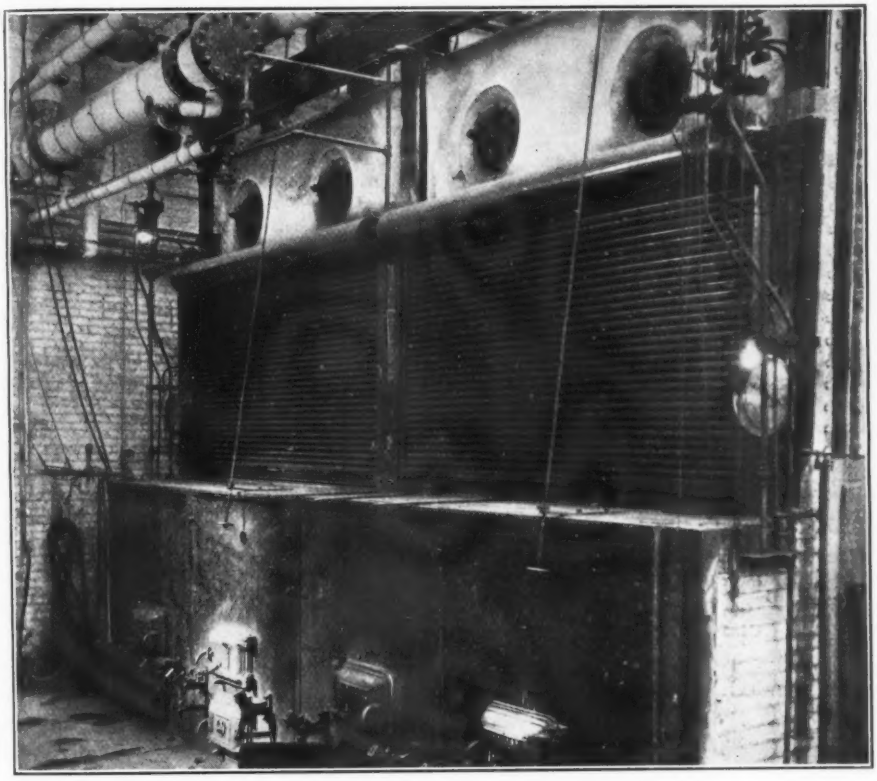


FIG. 2. FRONTS OF EDGE MOOR BOILERS

headers with handhole plates on the inside. Each has two horizontal drums with triple-riveted, double-strapped butt joints and is built for 200 pounds working pressure, but the ordinary pressure carried is 125 pounds. Two 4-inch Ashton pop valves are fitted to each boiler, Reliance water columns are used and two 2½-inch blowoffs are located in the bottom of the rear header. The blowoff valves are of Cadman type and are protected by Homestead straightway cocks.

The boilers are equipped with Twin Fire furnaces and Twentieth Century rocking grates. Fig. 2 is a view of the boiler and furnace fronts, and it will be noticed that the latter extend but slightly in front of the boiler setting. Each furnace consists of two longitudinal arches for two distinct fires: a connecting arch, and a short retarding arch immediately back of the bridgewall. The object is to provide ample surface of a refractory material which can be kept at a high temperature, reflecting the heat upon the burning fuel and completely consuming the liberated gases when mixed with the proper quantity of heated air. The volatile gases are not allowed to come in contact with the heating surface of the boiler, but are retarded in their travel over the highly heated arches long enough for complete combustion. Fig. 3 shows the boiler in cross-section. The grate surface under each arch is 4x7 feet, making 56 square feet per boiler and giving a ratio of grate to heating surface of 1 to 50. In the boiler settings a style of baffling is used which combines some of the characteristics of both the horizontal and vertical types, the gases finally passing out under the rear header and from thence to the stack, the outlet to which is controlled by a Locke damper regulator.

An interesting detail regarding the stack foundation will be noted in Fig. 4. The stack, which is of Alphons Custodis concrete construction, 6 feet inside diameter and 130 feet high, is located on a strip of ground 12 feet 4 inches wide lying between two buildings. The plans called for a foundation 20 feet square, but as a distance of 12 feet only was available in one direction, the foundation was arranged with tie rods to take up the tensional stresses due to wind pressure. Eighteen Simplex concrete piles were sunk 16 feet deep, and extending the entire length of each pile were four ¾-inch rods which, extending into the base of the stack, give it the necessary rigidity, a tension of 10,000 pounds per pile being allowed.

Piping

Beginning in front of the boilers, the main header extends straight through the wall to the pump room, where a tap is taken off from the top for auxiliaries. With the exception of the elevator pump, all the auxiliaries operate at 80 pounds pressure, to which the steam pressure is reduced by a Keiley reducing valve. Continuing on into the engine room, the header terminates in two tees looking upward, from which long-sweep bends lead to the engines. Austin separators are provided and the high-pressure valves and fittings are of Crane manufacture. The header and separators are drained by Anderson traps.

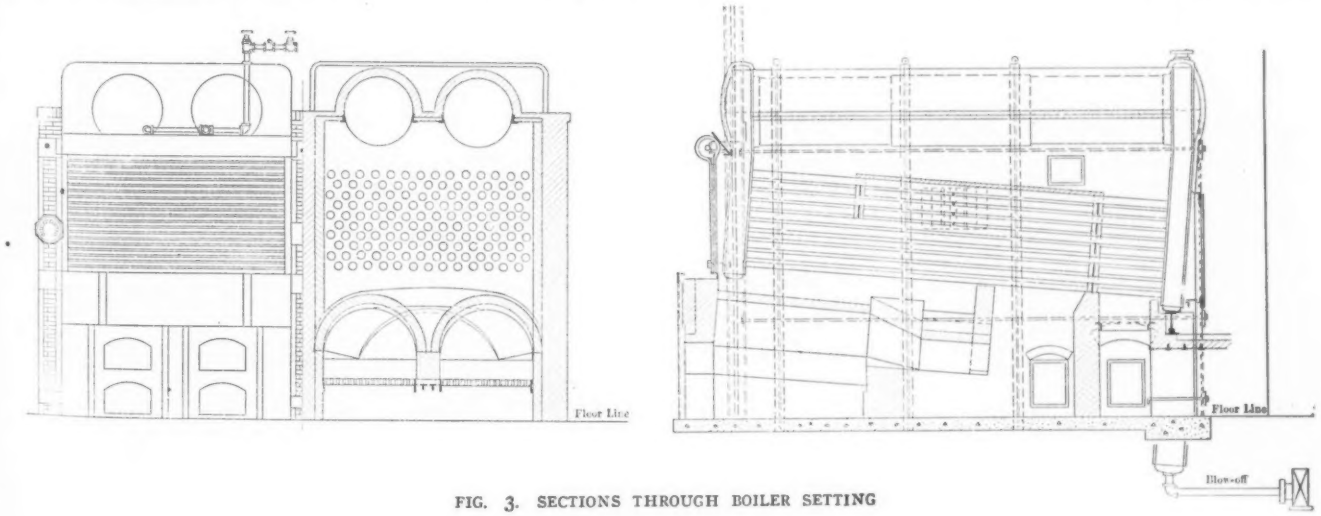


FIG. 3. SECTIONS THROUGH BOILER SETTING

Exhaust steam passes to a Stilwell-Bierce open heater in the pump room and is also used for various heating purposes throughout the building. Austin oil separators protect the heater and other devices from entrained valve oil. Excess exhaust steam is taken care of by a 12-inch exhaust riser, which extends to the roof of the main building and which is capped by a Swartwout exhaust head.

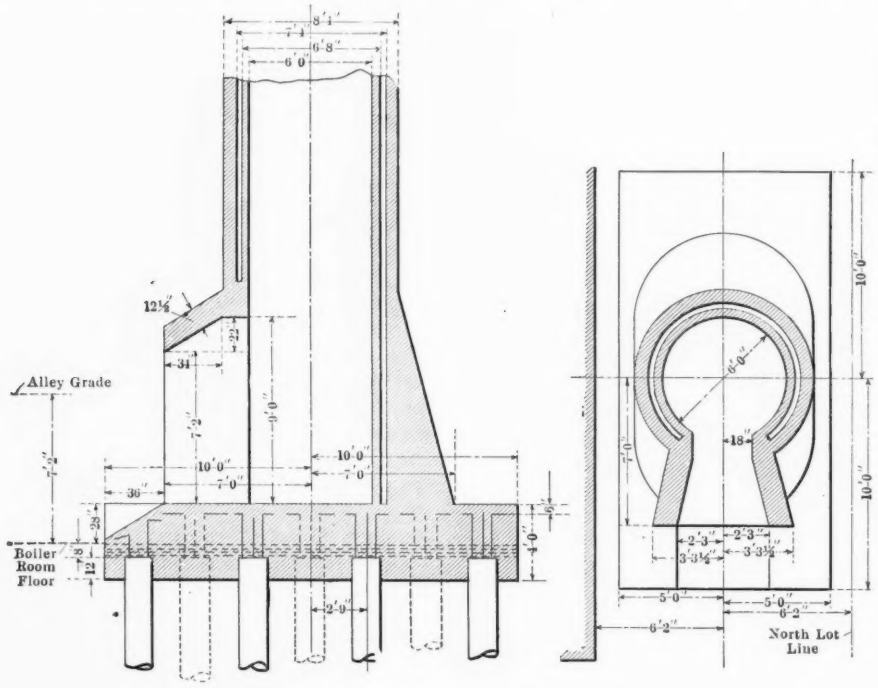


FIG. 4. DETAIL OF STACK FOUNDATION

Engine Room

Two generating units are now installed, and these are set at right angles to each other, as shown in Fig. 5. Each set is of 150 kilowatts capacity and consists of a Sprague 220-volt six-pole compound-wound generator driven by a Fleming-Harrisburg Corliss-valve engine with nonreleasing gear. The engines have 17x17-inch cylinders and run at 200 revolutions per minute. They are of the side-crank type, self-oiling, and have separate eccentrics for steam and exhaust valves. Forced lubrication is employed for cylinders and valves, using Hills-McCanna oil pumps.

Five panels of blue Vermont marble make up the switchboard which controls the electrical output of the plant. As shown in Fig. 6, there are two generator panels, each equipped with a voltmeter, ammeter, three-pole generator switch and a Duncan recording wattmeter. The distribution consists of two-wire 220-volt circuits for power, three-wire 110-volt circuits for lighting and also two-wire 110-volt lighting circuits. The new building is lighted entirely on the three-wire 220-volt system, using a balancer set. In the old building, however, the two-wire 110-volt system is installed, and it was necessary to equip the switchboard for handling the two classes of service. The connections are shown in Fig. 7. In operation it is necessary for the attendant to manipulate the double-throw switches so that the unbalanced load does not exceed the capacity of the balancer set. The latter is a 12½-kilowatt Sprague outfit running at 1400 revolutions per minute.

Pumping Equipment

In the pump room the heater is elevated 3 feet above the feed pumps, so that the water, which is kept at an average temperature of 210 degrees, flows to the pumps by gravity. The pumps are shown in Fig. 8. They are of the Marsh type,

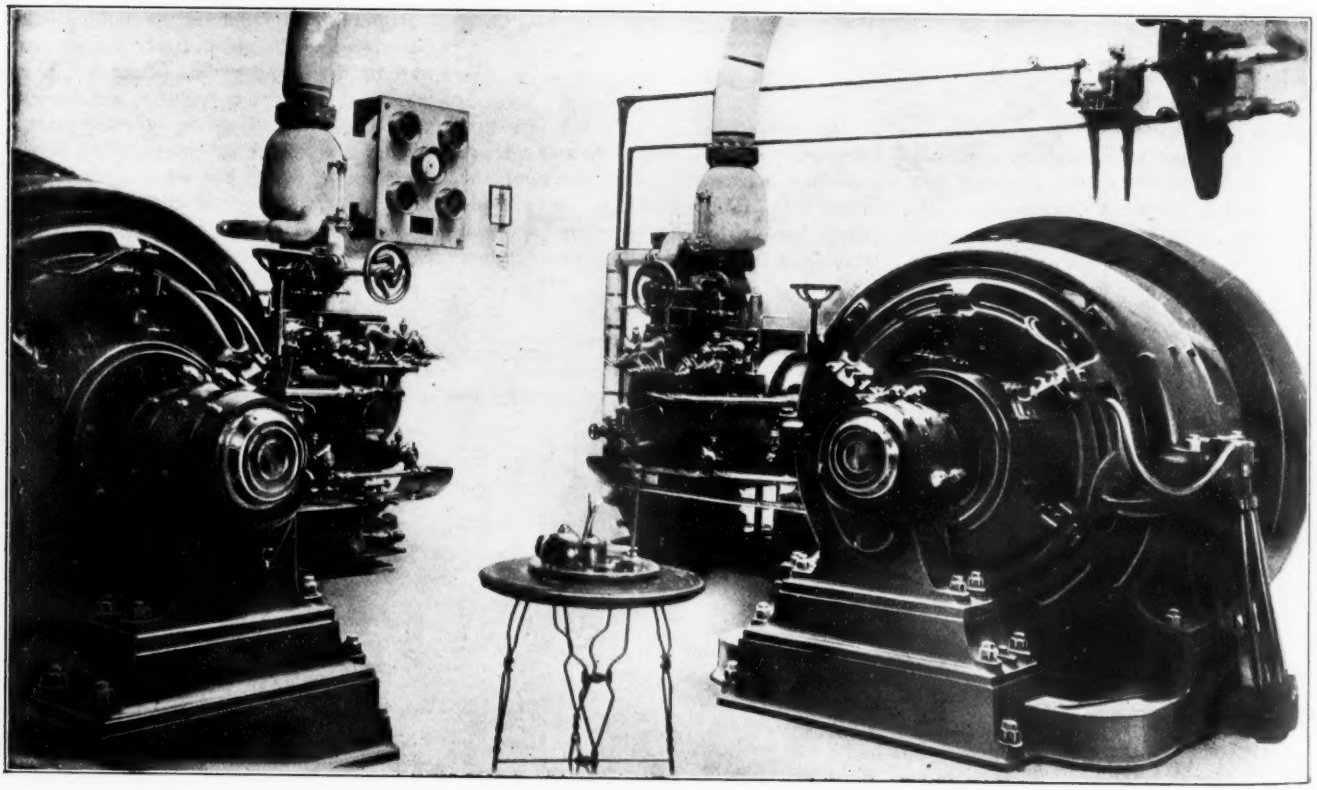


FIG. 5. ENGINE ROOM AT ST. LUKE'S HOSPITAL

12x7½x12 inches, and can take feed water direct from the city mains as well as from the heater. On the discharge side they are cross-connected in order that they may be used on the house service when desired. The feed line extending to the boilers is entirely in duplicate from the pump discharge, and a Ross feed-water filter is connected to the line. The vacuum pumps for exhaust-heating returns are also shown in this view.

There is also a 5x6-inch triplex pump driven by an 8-horsepower Sprague motor with Cutler-Hammer control, delivering water to a pressure tank in the basement under 50 pounds pressure. This water is used for house service and is furnished both hot and cold. The hot-water heater for this service is of the closed type, containing coils heated by exhaust steam, the water circulating on the outside of the coils. A smaller heater of the same type is installed to be used in emergency, but in this case the coils are heated with live steam, condensation being delivered to the feed-water heater by an Anderson trap. Other pumping equipment installed here consists of three elevator pumps discharging into a pressure-tank system at 85 pounds pressure to operate two Otis plunger-type elevators in the new building and also elevators in the old hospital. The main elevator pump is not of the distinctive Marsh type, although made by the same company. It is an American, tandem compound, long-stroke, outside center-packed plunger pump and has 12x20x14x20-inch cylinders. The pump is equipped with a positively actuated valve in the steam chest, which opens the steam ports to the main valve in a direction corresponding to the stroke that the pump is taking. The pump is governed by a Mason regulator. Two other pumps of the duplex type, one a Worthington and one a Gordon, are installed as reserve and are also cross-connected to the fire system of the building.

Located in the pump room is also a 25-ton Kroeschell carbon dioxide compressor, belted to a 35-horsepower Sprague variable-speed motor. The compressor has a 3½x16-inch cylinder, and the double-pipe condenser is installed directly above the machine. To economize in the use of water, the overflow from this condenser is discharged into a surge tank from which the house pumps get their supply. Low temperatures are distributed by means of brine-circulating pipes. Calcium-chloride brine is used, and the circulation is maintained by an 8x5x12-inch Marsh pump. The refrigerating service is used mostly in the various kitchens in the establishment, but part of it is used for cooling drinking water and for the morgue, and there is a cooler for furnishing ice-water baths for patients in the hydrotherapeutic room. Artificial ice is also manufactured, a plant being installed for this purpose in the basement of the old building capable of making 900 pounds of ice in 10 hours.

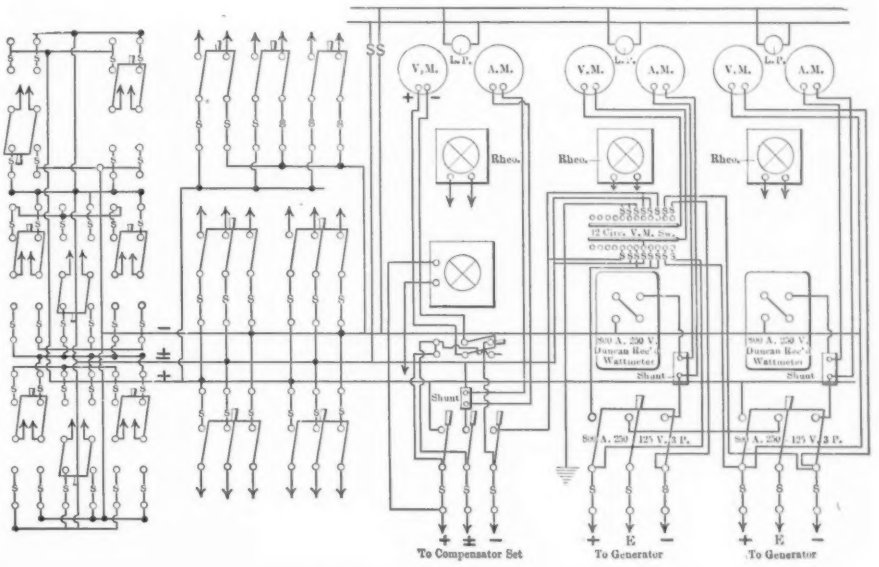


FIG. 7. DIAGRAM OF SWITCHBOARD CONNECTIONS

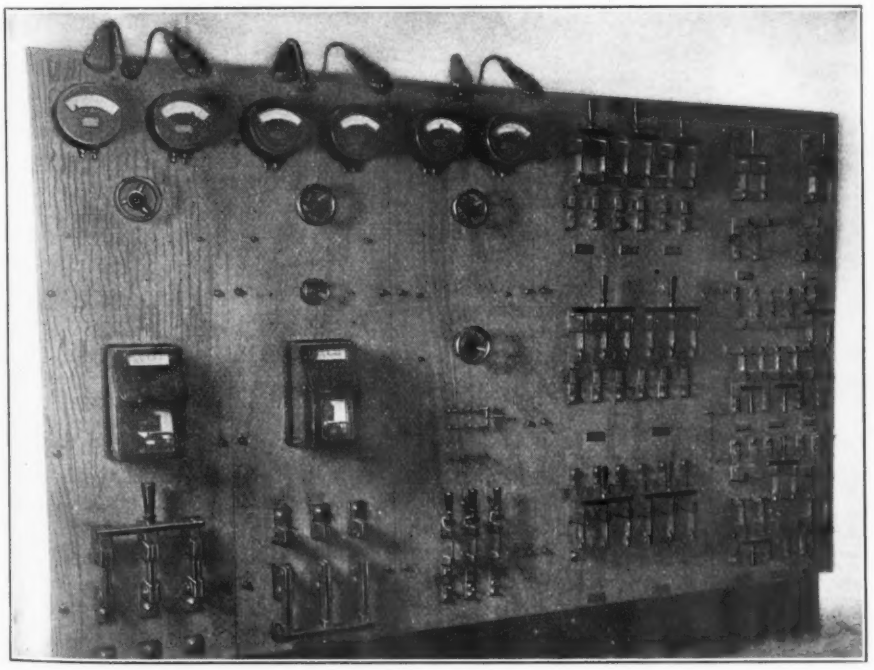


FIG. 6. THE SWITCHBOARD

Ventilation

In addition to the 35-horsepower refrigerating motor, there is a 15-horsepower laundry motor, a 10-horsepower motor for the sanitary vacuum-cleaning system and four 12-horsepower variable-speed motors on the ventilating system. One of the latter is shown in Fig. 9, and it will be seen that they are directly connected to their individual fans. Two of these outfits are used to supply air to the rooms, and two similar ones to exhaust the air after being used. They run at speeds ranging from 186 to 300 revolutions per minute, according to the demand on the system.

After passing the intake through the roof of the power house, the air passes through a tempering coil heated by exhaust steam, which brings it up to a temperature of about 68 degrees. It is then washed by a spray of water circulated by a 1-horsepower motor, direct-connected to a single-stage centrifugal pump. After being washed the air passes a bank of re-heating coils, which are regulated by thermostats on the upper floors. Each room has an inlet and an outlet, one being at the top of the room near the ceiling and the other at the floor. At four different points in each wing of the building, viz., in the basement, first, third and fifth floors, are thermostats which regulate the temperature of the incoming

air. These are set at 70 degrees and the accumulative action of all four of these thermostats is necessary before reducing the temperature of the air, but any one of them may act in increasing the temperature.

Connections of the air ducts are arranged in such a manner that in cold weather the fresh air enters the room at the bottom opening and is taken out at the top, while in warm weather, if desired, cool air can be admitted at the top and taken out at the bottom.

In addition to the heating and ventilating system just described, there is an auxiliary system of direct radiation which takes care of the building losses. This system consists of radiators in each room under the windows, controlled by independent thermostats. They are heated by exhaust steam, and are connected to the Van Auken vacuum-return system.

For the operating rooms there is a separate indirect heating and ventilating system which takes its air supply from the main current of air and has an independent blowing outfit consisting of a 1-horsepower Sprague motor and direct-connected fan. The temperature in the operating rooms can be maintained at any predetermined point, depending on the vitality of the patient, through the same system of Johnston thermostat control. All the air entering the operating rooms is filtered through medicated gauze.

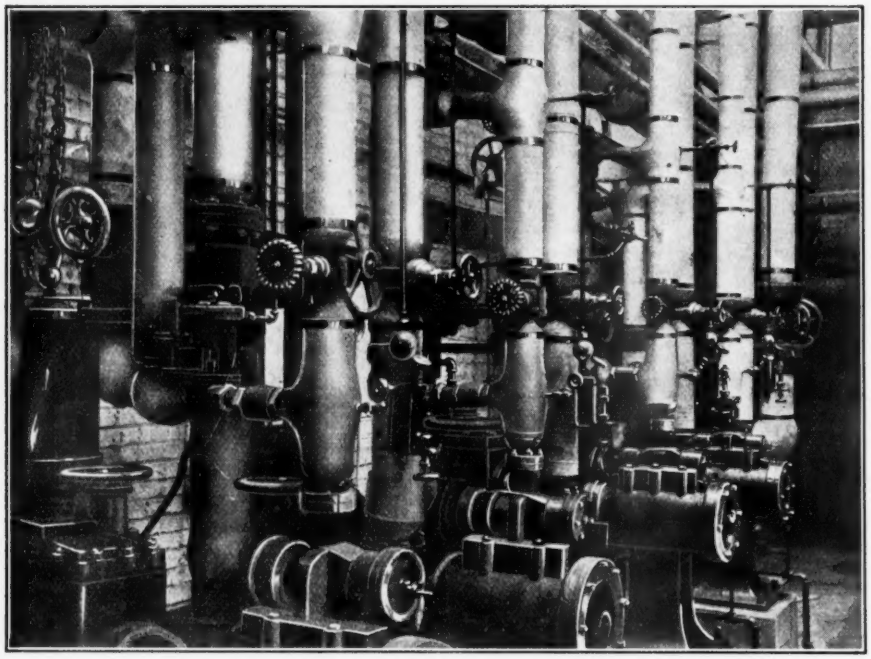


FIG. 8. SOME OF THE PUMPING EQUIPMENT

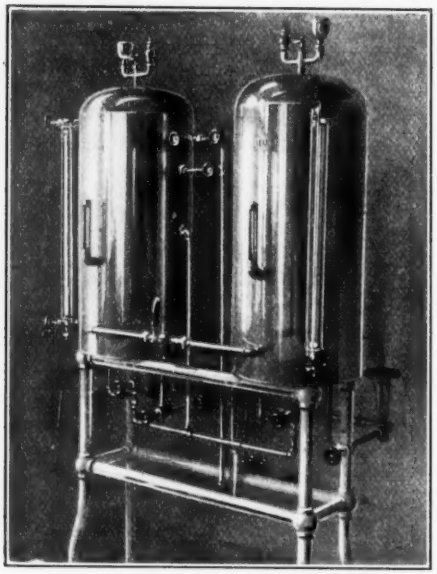


FIG. 10. RESTERILIZER IN SURGICAL DRESSING ROOM

Uses for Live Steam

Live steam is used in the laundry and also to heat the steam tables in the kitchens, one of which is located on each floor. Water is distilled by live-steam coils, under a vacuum maintained by a small Marsh vacuum pump. The distilled water is then pumped from a reservoir to all parts of the building and furnished both hot and cold and also as drinking water.

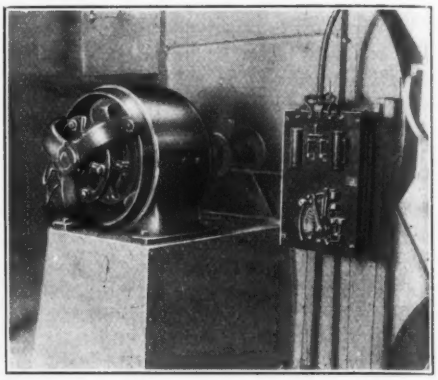


FIG. 9. MOTOR DIRECT CONNECTED TO VENTILATING FAN

In the surgical dressing room is a resterilizer, Fig. 10, used exclusively for surgical purposes. This takes the distilled water and re-boils it under pressure at 240 degrees by means of steam coils. The water is then cooled by cold-water cooling coils to any desired temperature. Both tanks are fitted with thermometers and regulating valves, which make their operation automatic. An apparatus working on a similar principle, but much larger, is located in the

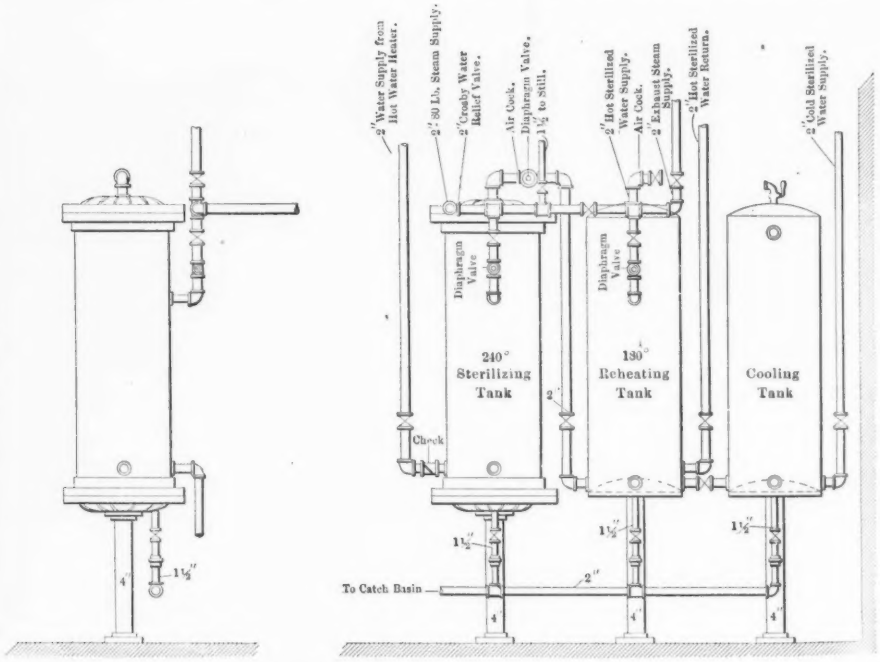


FIG. 11. STERILIZER TANKS AND PIPE CONNECTIONS

pump room and furnishes both hot and cold sterilized water for the entire building. Fig. 11 shows an elevation of the apparatus, which consists of three vertical tanks supplied with water from the hot-water house service. In the first is a steam coil into which steam is admitted at 80 pounds pressure. The inlet to the coil is controlled by a Johnston thermostat and diaphragm valve which keeps the contents of the tank at a temperature of 240 degrees. Condensation in the coil is removed by a high-pressure Anderson trap. The outlet to the first tank is also controlled by a thermostat, which opens the valve at 240 degrees, allowing the water to flow to the second tank. A cooling coil in this tank brings the water down to a temperature of 180 degrees, at which temperature it is circulated throughout the building. There is also in this tank an exhaust-steam coil which can be used to raise the water to 180 degrees if for any reason it should fall below this point. Each of these coils is controlled by thermostat and works automatically. The third tank contains cooling coils by which the sterilized water is cooled to an ordinary temperature before being circulated in the building.

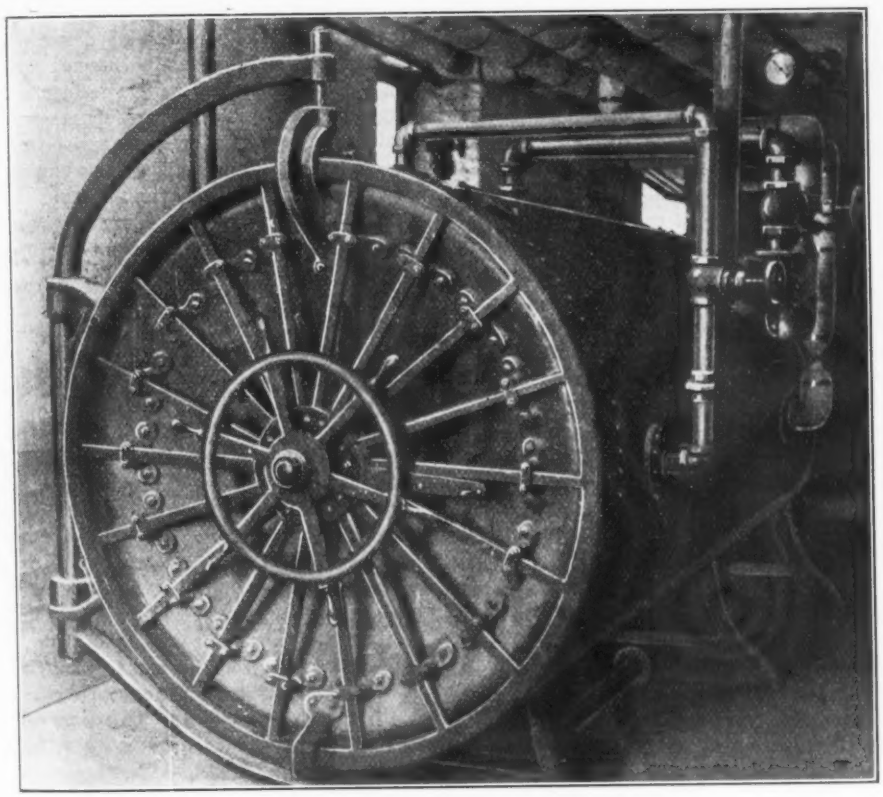


FIG. 12. LIVE-STEAM STERILIZING TANK

Another apparatus taking live steam is the disinfector or sterilizer shown in Fig. 12. This consists of a horizontal steam-jacketed tank of boiler plate, with a swinging door which can be made up with a gasket steam tight. In this receptacle may be placed beds, clothing or other similar articles which it may be desired to sterilize. The steam inlet may be regulated to maintain any desired pressure or temperature either in the jacket or in the interior of the sterilizer, or while being subjected to steam temperature in the jacket, the contents may be subjected to a vacuum produced by a steam jet attached to the apparatus. Five small sterilizers, built on the same principle, are used in the operating rooms for dressings, etc.

In the electro-therapeutic room are a complete X-ray outfit and motor-driven static machine. A motor generator in this room supplies alternating current at 110 volts, which is distributed to the operating rooms, where it may be reduced by variable-voltage transformers to from 3 to 10 volts for use in the operation of electric knives and cauterizing devices, the amperage varying from 25 to 100. This low-voltage current is also used for lighting miniature lamps and for other surgical purposes.

In place of the ordinary bell system, there has been installed an elaborate system of signaling by colored lights, which does away with all unnecessary noise and provides for signaling any nurse or interne from the office. Patients call the nurse by pressing a button which lights a small red lamp in the hall over the door and also a drop at the head nurse's desk. All rooms have telephones, and a private exchange connects all departments of the institution.

The mechanical equipment of the hospital was installed under the direction of Pierce, Richardson & Neiler, consulting engineers, of Chicago. E. J. Searles is engineer-in-charge of the plant.

Tribulations of a Gas Power Pioneer

By T. F. Christopher

A small central station which had outgrown its capacity and was facing a steadily growing demand was rebuilt, after as thorough an investigation of other plants as possible, and, as the result of the information obtained, it was decided to change from steam to gas power. Accordingly, contracts were made with those manufacturers whose apparatus seemed best suited to the work, these contracts being first submitted to a firm of consulting engineers for modification wherever advisable.

The date of shipment finally arrived, but the machinery did not. As a certain part of the purchase price was to be paid on presentation of shipping papers, the company was daily expecting to be called upon for this payment. Instead of this, however, there came a notice or request from the manufacturer of the engines for three months' extension of time for shipment, changing the time of shipment to practically the date on which the plant was to be installed and ready for operation. The producer manufacturer, however, notified the company that the producer parts and materials were all ready for shipment and asked if engines were going forward, as it was arranged that the producers and engines should be erected simultaneously in order to economize in labor expense. Of course, the producer shipment had to be deferred. Meanwhile, the company's investment in the additional property, building, poles, line wires, electric generators, switchboard, transformers and all the miscellaneous material to be utilized with the engines in completing the new station, was hung up for three months without an opportunity for the money to earn anything toward promised dividends to the investors. This, however, was a small feature of the trouble. Contracts with the municipality for new street lights, with industrial establishments for power and lights, and with new individual consumers had to be extended or cancelled, according to the attitude of the customer, and this caused a loss of confidence which had a commercial value not easy to compute and much greater than the actual money loss. The municipal contract was a particularly serious affair; the failure to supply the current as agreed for a specified number of days in succession carried not only severe penalties, but gave the council the right to cancel the franchise with all its rights to sell and deliver current in the municipality to any other customers. The only thing left to do was to explain the unavoidable delay and ask the indulgence of the city council, purchase some new generators and overload the steam engines until the gas-power equipment could be installed.

Trouble in Starting Up

At the end of the three months, one of the gas engines and the corresponding gas producer were shipped and in due course of time erected. When the plant was ready to start, every person from general manager to pick-and-shovel-operator was present to see "the wheels go round." The producer was making gas all right, the holder was full, air tanks had been pumped up to proper pressure, and everything seemed in readiness. The last thing to do before starting engine into operation and turning on gas was to turn cooling water into the engine jackets. The water supply was under considerable pressure and as soon as the spaces had been filled every joint about the engine squirted water; not a single gasket from inlet to outlet was tight enough to hold water, and new gaskets had to be fitted to every joint on the engine; this took considerable time, and another starting time was appointed. This time the engine started all right. After running a while on friction load only, the switch was thrown and partial load picked up; the immediate result was a series of detonations from the air pipe of the engine which scared the uninitiated into flight. All known changes at the mixing valve did not overcome the difficulty, and after diligent search for the cause it was found that the jacket outlet was discharging not water but steam, and no amount of opening at the inlet or increase of pressure could cool it down; there were spots on the cylinder and valve cages too hot to be handled. This meant another shutdown and a hunt for the cause. It was found in pieces of core remaining in the water space, and several times subsequently trouble with the circulating water was caused by small pieces of core or core wire clogging the openings to the water outlet.

All these difficulties were developing under the supervision of the manufacturer's erecting engineer, and his daily reports fully described the troubles and their causes. With all these reports at hand relating to the first engine, one would naturally suppose that the defect would be carefully corrected in the second engine, but almost every difficulty experienced with the first engine was duplicated in the second one.

With only one of the engines running it was impossible to change from the old plant to the new; until the arrival and installation of the second unit, therefore, the first one was merely tested and its "bugs" weeded out. When the second engine was installed and the experience derived from handling the first had brought the two on a parity so far as overcoming difficulties that had developed up to this time (only a little more than friction loads had been used) could do, considerable load was thrown on engines; most alarming backfiring immediately began. Reports of the trouble to the manufacturer brought the accusation that the gas must be bad, that the engines could not operate in such a manner with good gas. Samples of the gas were taken from the line when the engines were kicking up in their worst manner, but these were not sufficient evidence. Special experts from the shops were sent to the plant to analyze the difficulties.

Manufacturer's Seeming Indifference

All this time, covering several months, the seeming indifference of the gas-engine manufacturer to help the purchaser fulfil his obligations, assumed entirely on the promises and guarantees contained in the engine contract, was engendering a deplorable spirit of antagonism between the contracting parties.

That the backfiring was due to the quality of the gas supplied by the producers was disproved by calorimeter tests and analyses made every few hours. Then dirty gas was charged as the cause, and for a time it seemed as though this might be the source of the difficulty, for upon opening up the manifolds and inlet pipes heavy deposits of soot and carbon dust were found and at each angle in the inlet pipe there had accumulated heaps of this material. This was photographed and sent to the manufacturer's shops by one of the investigators as a discovery that would shift the responsibility for all the troubles over to the producer manufacturer.

The operator of the producer plant claimed that the gas made was practically clean and demanded an examination of the gas main and holder, claiming that if the gas was dirty and the deposits found were caused by dirt in the gas that these deposits would be heaviest in the holder, and along the lines from the holder to engine. He further claimed, and finally proved, that the cause of these deposits was the backfiring of the engines. These explosions, occurring while the inlet valves were open, burned the gas in the manifold and blew the residue of the imperfectly burned gas back through the gas main toward the holder; this was indicated by the fact that at each backfire the gas holder was seen to lift, and a test flame on the main near the holder was extinguished. The gas main was opened from the engines back toward the holder, and an examination showed that a short distance from the engine the deposit decreased, and farther on ceased altogether.

No amount of nursing, adjusting, or other attention cured the backfiring, and this tinkering extended over a period of about two years, during which time the service had, of course, got into disrepute with every consumer. Besides the backfiring, other but minor troubles arose and were corrected; the backfiring, however, manifested a tendency to emulate Tennyson's brook. Some days the engines would run fairly well all day and just as the heavy lighting load would come on in the evening and it was especially necessary to have them working they would commence backfiring and lay down. The municipal authorities had become so disgusted with the whole unsatisfactory service supplied that when another company applied to them for a franchise the application was received with favor.

New Oil Helped Considerably

About this time and while the negotiations for a settlement between manufacturer and purchaser were pending, a man selling oil applied at the power station and asked them to try some cylinder oil he was introducing for gas engines. The erecting engineer, being under orders from manufacturers to use the oil they had designated, was afraid to make any change. The superintendent proposed making a trial of the new cylinder oil and finally ordered a barrel shipped for test. The engines were gradually showing signs of improvements and better performance from day to day as further changes were made. The new cylinder oil arrived and was put into use on all of the engines. Improvements in operation became apparent at once, and a big stride toward successful operation of the plant had been made.

There still remained a considerable amount of unsatisfactory performance, and for this reason a renewed effort on the part of the company was made to have the manufacturer bring the plant up to what it was supposed to have been at the time of purchase. A conference was held between the company, the manufacturers and the consulting engineers, and the conclusion arrived at was that the engines must be operated at reduced speed and correspondingly reduced power, the builders of the engines agreeing to make satisfactory allowance for the reduction in power and also for the damage suffered by the company, and that additional equipment should be installed. This plan was carried out.

The engines that had been giving all the trouble for the two years continued to show improvements with the new cylinder oil; the backfiring that had continued almost without interruption from the day they were installed occurring only at odd intervals. Slight changes in the ignition, a little adjustment of the mixing valves, a little more water to the jackets would often correct the trouble, and each day the continued corrections of one part or another seemed to bring them nearer to commercial operation and some degree of reliability. By the time the additional engines had arrived and been installed, the old engines were operating satisfactorily. Then the steam plant was abandoned and dismantled.

Three years have passed since that was done. The station is now greatly increased in capacity over the original installation, and even the engine manufacturer uses it as a reference without hesita-

tion. The two and a half years of grief, sleeplessness and trials are only remembered as a bad dream.

Poor original design, careless workmanship and bad cylinder oil, combined with a special kind of business "management" on the part of the manufacturer caused unnecessary loss to everyone connected with the deal, but the manufacturer learned a lesson and obtained information and experience to enable him now to supply a first-class gas engine without danger of duplicating the experience.

Catechism of Electricity

869. *How does an induction motor operate under varying loads?*

Very much like a direct-current shunt-wound motor. In both, the armature current and torque depend upon an impressed and a counter-electromotive force; in the direct-current motor the impressed electromotive force is supplied from the line wires through brushes, while in the induction motor it is induced by the current in the field winding. The speed of both types varies inversely as the load varies. In the induction motor the torque varies as the square of the applied voltage, while the torque of the shunt-wound motor is practically independent of the applied voltage. On the other hand, the speed of the induction motor is not affected directly by variations in the applied voltage, while that of the direct-current motor is controlled by the applied voltage.

870. *What methods are employed for controlling the speed of an induction motor?*

The speed may be controlled in three ways: By varying the impressed electromotive force, by varying the armature resistance or by changing the connections of the field winding. In the last method the speed is increased by changing the winding so as to increase the number of poles and is decreased by changing the winding so as to decrease the number of poles. The use of the second method requires a specially wound armature, but this method provides the most efficient means of varying the speed. The first method is a decidedly inefficient one and is inferior to the other two methods because it controls the speed by affecting the torque of the motor.

871. *How is the direction of rotation reversed?*

By reversing the direction of the current through *one branch* of the field winding. This is easily done by reversing any two of the supply wires connected to the field winding.

872. *Is the rotating field always produced by the stationary member of an induction motor?*

Not necessarily. The revolving member may be made the primary, using collector rings and brushes to connect it with the line, and the short-circuited armature winding would then be on the stationary member. The rotating field would tend to draw the short-circuited member around after it, but as that member would be held stationary, the moving member would be pulled around in a direction opposite to that in which the magnetic field would rotate. Such a motor would have no important advantage and the serious disadvantages of moving contacts and revolving high-voltage windings.

873. *What are the disadvantages of the induction motor?*

The greatest disadvantage is its low power factor, which entails a larger current for a given voltage and output than other motors. This in turn causes a greater loss in the lines and necessitates greater station capacity. Furthermore, the lagging current taken by an induction motor makes difficult the regulation of voltage on the circuit.

874. *In what respects does a single-phase induction motor differ from a polyphase induction motor?*

The outward appearance is about the same and the principles of construction are identical. The single-phase motor has a somewhat lower efficiency and power factor, and when running with no load, a single-phase motor takes considerably more current than a polyphase motor.

875. *What method of starting is used with single-phase motors?*

A device frequently used consists of an inductive coil or a condenser in series with a special starting winding on the motor. This arrangement causes the current in the special winding to be out of phase with the current in the regular winding, converting the machine temporarily into an unsymmetrical sort of two-phase motor having sufficient torque to start the armature without load.

876. *What are average values for the efficiency, power factor, speed and current at different loads of a small single-phase induction motor?*

A general idea of these values may be obtained from the four curves in Fig. 284, which were plotted from a test of a 3-horsepower 114-volt single-phase induction motor. The scale along the base line represents percentages of full load; the vertical scale at the left gives the values of efficiency and of power factor; and the vertical scale at the right refers to speed in revolutions per minute and current in amperes, the former near the top and the latter near the bottom of the diagram. Reference to the diagram shows that at half load (50 per cent. of full load) the speed was 1740 revolutions per minute, the efficiency 77.5 per cent., the power factor 77 per cent. and the current 21 amperes. At full load (100 per cent.) these values were 1720, 70, 81 and 41.5, respectively.

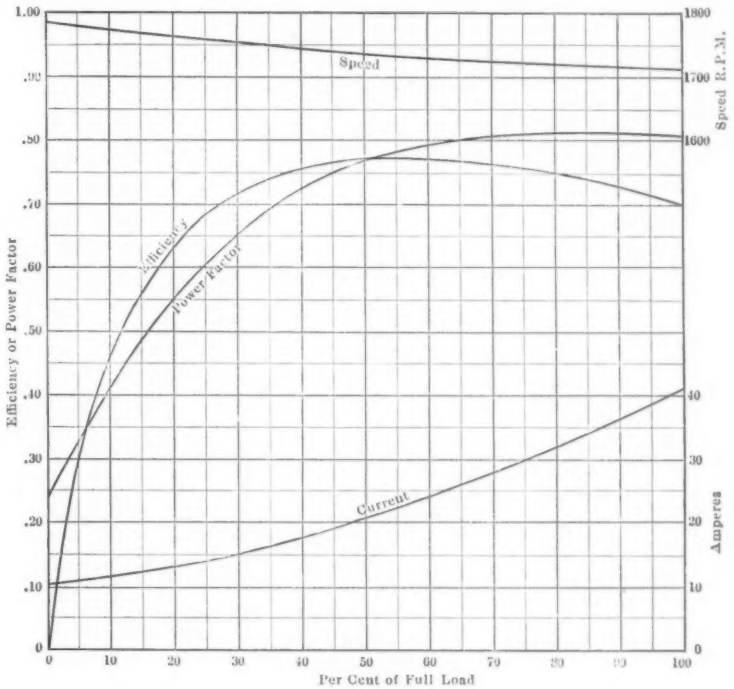


FIG. 275. CURVES OF A SINGLE-PHASE INDUCTION MOTOR, SHOWING AVERAGE VALUES OF EFFICIENCY, POWER FACTOR, SPEED AND CURRENT AT DIFFERENT LOADS

Practical Letters from Practical Men

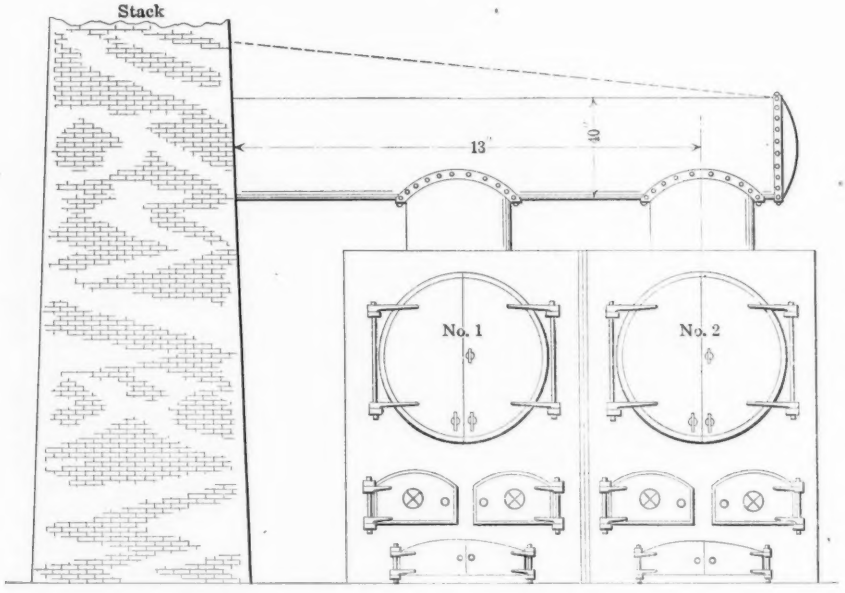
Don't Bother About the Style, but Write Just What You Think, Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

Steaming Power of a Boiler Increased

How the steaming power of a boiler was increased is shown in the accompanying illustration. There were two horizontal return-tubular boilers, each 72 inches by 18 feet, having seventy-eight 3¼-inch tubes. The smoke connection was constructed as shown in the drawing. This connection was 40 inches in diameter and 13 feet from the brick stack to the center of the farther boiler.

With these two boilers operating on a 10-hour run, No. 2 boiler would require, under the same load, 525 pounds of coal more on the run than No. 1 boiler, all other conditions being the same. We began to investigate. Each boiler had 796 square inches of tube area, or a total of 1592 square inches. The smoke flue had an area of 1256 square inches, or 336 square inches less area than the boiler tubes, while it should have been more by at least 10 per cent.



INCREASING THE STEAMING POWER OF A BOILER

The top of the smoke flue was raised, as shown by the dotted line. The one boiler would then do equal work with the other, no other change being made.

In another instance, where a long horizontal smoke flue of this kind was used, it was raised at the end entering the stack and the efficiency of the boilers was increased at least 25 per cent.

We seldom get too much draft and when a fireman says one boiler pulls more than the other, it will pay to look into the matter.

C. R. McGAHEY.

Lynchburg, Va.

Culm and Coal Dust for Fuel

About twenty coal companies in Virginia and Pennsylvinia, and some in New York, have been making briquets during the last five years, and as I have seen a good many samples, I am convinced that one ton of briquets is equal to two tons of coal. The cost of production is too expensive, however, and the burning of briquets creates smoke and bad odors, as considerable tar and pitch are used as a binder.

The writer visited a briquet plant recently, and the superintendent informed him that briquets are not marketable for these reasons. I know of a man who has a binder which will do the work, and a number of tests has proved that a ton of briquets made of anthracite dust equals three tons of the best anthracite. It is absolutely smokeless and odorless, and leaves 11 per cent., or less, of ashes, with no cinders and clinkers, and burns without extra draft. The binder is unlimited in quantity and is a by-product, the same as tar and pitch. It can be had at a cost of from 50 to 60 cents a ton.

The machinery in the briquet plant mentioned is entirely too expensive and too complicated, costing between $75,000 and $80,000, with an output of 35 tons per day.

To make briquets a commercial success it will be necessary to obtain a machine which will handle culm and dust alike with any kind of a binder. The output of the machine should be about 5 tons per hour and not more than two men should be required to run the mixer and machine.

JULIUS JETTER.

Camden, N. J.

High and Low Water Alarms

Regarding the advantage of the high- and low-water alarm, I would no more think of throwing mine away when I had a feed-water controller, or regulator, than I would to throw away the steam gage when I had a damper regulator. I have used two different feed-water regulators; the first one had to be overhauled about once a week, and as it could not be depended upon, it was taken out. The second one was put in by the former engineer and it is giving good satisfaction. The firemen are instructed to watch it as closely as they would the water without one, and once in a great while we find we are justified in doing so.

I have seen a different make in power plants and the water tenders have told me that they were the best they knew of, but that they all required overhauling about once a month or nearly so. I fail to see why the alarm should be condemned when a regulator is put on, for when a regulator regulates the alarm has nothing to say, and it is not in the way.

I do not wish to detract from the merits of a good feed-water regulator, as they are good things, but unless one has a careful fireman he will get in the way of putting too much confidence in them. I have found that firemen are careful to watch the water when there was an alarm on the water column, because if it got to blowing very often the engineer is sure to come around to find out what is the matter.

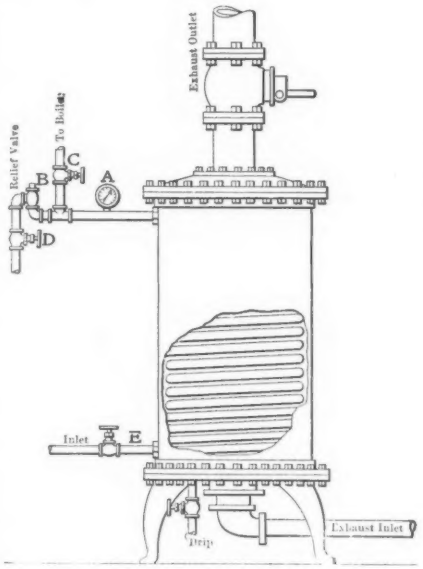
C. B. SMITH.

South Framingham, Mass.

Closed Heater Strains

It is safe to say that few engineers realize the enormous pressure sustained at times in the coils of a closed feed-water heater not supplied by a relief valve. By referring to the accompanying illustration an idea will be gained of the way this pressure is produced.

When testing a heater we attached a steam gage capable of registering 300 pounds, at *A*, and a stop valve at *D*, because the relief valve *B* was set at 200



HOW PRESSURE IS PRODUCED IN HEATER COILS

pounds. The steam gage registered 300 pounds pressure and then it slipped three cog gears inside the gage; this means at least 200 pounds more, and the coil must have sustained a pressure of at least 500 pounds. This is what is going on every day in heaters having no relief valve.

The coils of a certain type of heater hold about 10½ gallons of water, or 2425 cubic inches weighing 87.46 pounds, at 60 degrees Fahrenheit. One cubic foot of water at 62 degrees Fahrenheit weighs 62.355 pounds, whereas, when heated to 212 degrees Fahrenheit, only 59.76 pounds are required to equal the same cubical contents. We have, therefore, 2425 cubic inches, or 87.46 pounds of water inclosed in approximately 1 4/10 cubic feet of space at 60 degrees Fahrenheit. By applying heat this water is heated to 212 degrees Fahrenheit, and heating the water expands it, and an enormous pressure may be obtained.

In another heater I filled the coil with water and disconnected the piping at the bottom of the intake, permitting the water to drain out, and found that the coils contained 78 pounds (1¼ cubic feet) at 60 degrees Fahrenheit. Then I connected the piping up again and filled the coil until water came out at *A*, the steam gage having been removed. Exhaust steam was then applied and the water in expanding flowed out at *A* while heating up to 212 degrees, amounting to 4 pounds in the pail or 5 per cent. more than I had at the start, although the heater was even full. This well illustrates the expansion which takes place in water when heated.

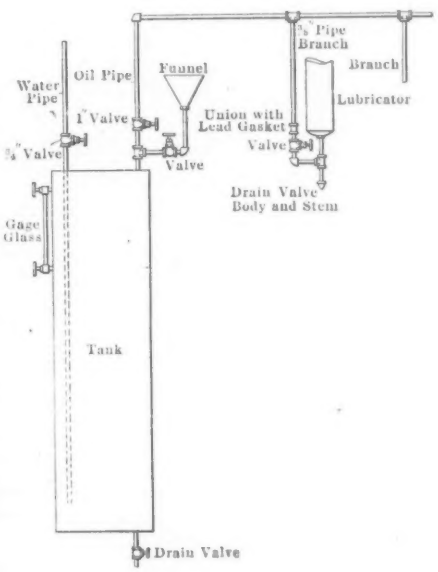
For the above reason I would advise putting on a relief valve on the feed-pipe line, located as far from the heater as possible, as this strain is decreased thereby.

A. C. WALDRON.

Lynn, Mass.

Filling Lubricators with Oil

I have seven lubricators, three of which are one-third pint, without gage glasses. The frequent filling was troublesome, and the pump generally gave warning when the lubricator was empty. I had heard of the idea illustrated herewith, and so rigged one up for myself. It consists of 23 feet of 4½-inch pipe. The drain pipe from the lower end of the tank to the drain valve is 1-inch pipe. The tank and drain pipe have a fall of about ¼ inch to the foot. The 1¼-inch oil pipe has two 1¼x1¼x½-inch tees for gage-glass connections. The 1¼-inch pipe goes to the oil valve and is reduced to 1 inch. The main oil pipe is 1 inch. I used ½-inch pipe when I first put the system up, but in cold weather the oil got too stiff to force through. In connecting to the



FILLING LUBRICATORS WITH OIL

lubricator a lead gasket was used.

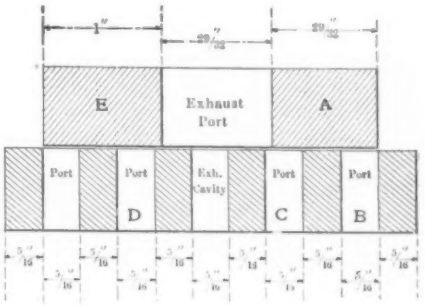
Should anything go wrong with the tank or piping the oil valve next to the lubricator should be shut and the water valve opened on the lubricator, so as to run the lubricator independently. I believe this is a great saving of oil, which is the principal thing to look out for. It is a hard matter to fill a small lubricator without wasting some oil. Of course the water pipe has to be elevated above the oil pipe to give sufficient head of water to force the oil to the lubricator.

THOMAS EDDY.

Macomb, Ill.

Wants Pump Valve Information

Will someone explain why the pump valve shown in the illustration is made as it is? It is the valve of a Worthington duplex pump, and both valves are exact



DUPLEX PUMP VALVE AND SEAT

counterparts. The singular features are in the relation of the valve to its seat and the difference in the proportion of one end to the other.

Particular attention is called to end *A* of the valve, which admits steam to port *B* before closing the exhaust port *C*, or opening *D*. What is the object, if any?

C. T. MCKNIGHT.

San Antonio, Tex.

Testing Boilers

I have been a reader of POWER for a number of years, with a great deal of pleasure and profit, and have found that in a great majority of cases statements made in your columns were correct. I would, however, like to call your attention to a reply made to W. A. H. in the "Inquiries" column of the October 20 issue. He is told that a boiler under test should be "cut out" entirely from all other boilers on the same header, both as to steam and water connections.

The water connections must, of course, be entirely separate from the feed lines leading to the other boilers, but the steam connections can remain as they usually are, unless the purpose of the test is to determine the steam consumption of the engine, or other machine consuming the steam. Calorimeter connections should be made in the steam connection of the boiler under test before the header is reached.

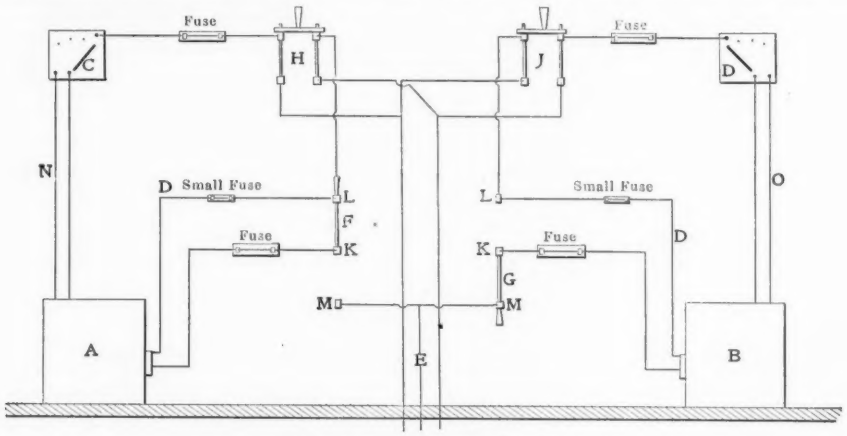
If it were necessary to give boilers under test a separate steam connection, no opportunity would be given, in the great majority of cases, to make tests, as the cost to make the necessary changes would be prohibitory.

A. B. CROZIER.

Kansas City, Mo.

A 500 or 250 Volt System for Motors

A method of wiring one or more motors, so that it is possible to run them at either 500 or 250 volts, without using an expensive controller, is shown in the illustration. Motors wired in this way can be used at either voltage without using the expensive controller usually employed for this purpose. By studying the accompanying sketch the idea is easily understood.



METHOD OF WIRING MOTORS

In the illustration, *A* and *B* are two 500-volt shunt-wound motors; *C* and *D* are two ordinary starting boxes, such as would be used for motors running at any voltage; *E* represents a three-wire circuit, having 500 volts between the outside wires and 250 volts between either outside wire and the neutral or central wire; *F* and *G* are two double-throw single-pole knife switches, and are used to change the current from 500 to 250 volts on either machine; *H* and *J* are double-pole knife switches such as would be used with a voltage of 500.

To put the motors in operation at 500 volts all switches are open. Suppose we wish to run the motors at 500 volts, it can be seen that the stationary point *K* of the double-throw single-pole switch *F* is connected directly to the return from the motor, and when this switch is open no current can pass through the armature circuit.

To start the motor at 500 volts, throw the single-pole switch in position to make contact from point *K* with point *L*, which is connected to one pole of the two-pole switch, and gives a 500-volt circuit.

To run at 250 volts, all switches being open, throw the double-throw single-pole switch so that contact will be made with switch from point *K* with point *M*. This makes the armature circuit run on the 250-volt circuit, as point *M* is connected with the neutral wire.

Following the shunt-field circuit marked *N O*, starting at the starting box, as is usually the case, make connection at point marked *L* on the single-pole double-throw switch, after leaving the motor. This always gives the field circuit 500 volts, no matter whether motor is running at 500 or 250 volts. The reason for this connection is to insure 500 volts for the field circuit. If the return from the field circuit led into the main return, as is usually the case with shunt motors, the field circuit would only have 250 volts when the motor was running at 250 volts.

By using this method of wiring either of these motors could be run 250 volts and the other at 500 volts, both at 250, or one alone at 250 volts. The cost of installing is much less than it would be if using a controller built for use at 250 or 500 volts. There is no complicated controller to get out of order that would require the services of an expert to locate the trouble; everything is on the switchboard and the operation of the motor can be easily traced by anyone who has an ordinary amount of knowledge of the operation of a shunt motor.

The small fuses are for the protection of the field circuit, as when, as occasionally happens, the main fuse on the return circuit connecting with *K* might be blown and the fuse to the controller from the other side of the circuit not be blown, there would still be a circuit through the fields. This fuse should be of small capacity a little more than sufficient to carry the field current. This contingency would rarely if ever occur, but it is as well to use it.

A. Chisholm.

St. Louis, Mo.

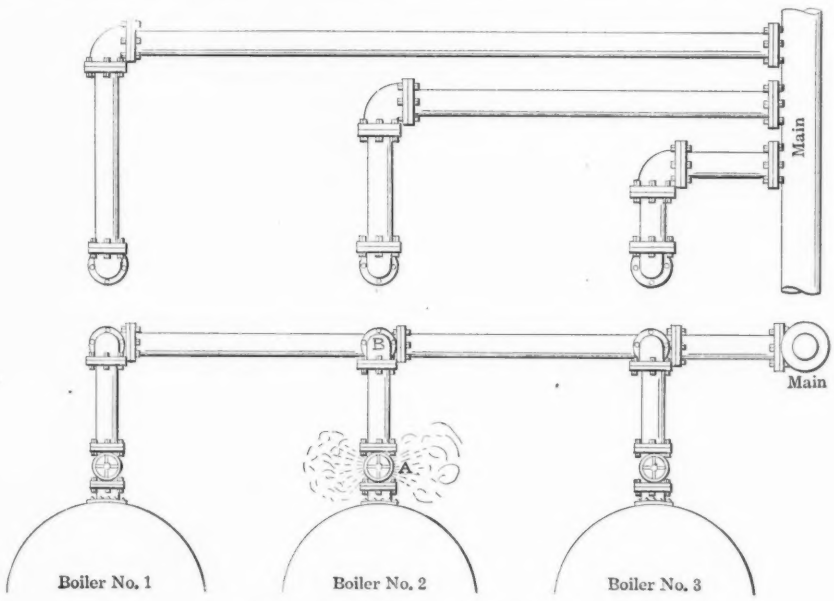
Weak Valve Caused Trouble

Three boilers were piped as shown in the sketch. With Nos. 1 and 3 on the main and No. 2 cold, I noticed that the stem of valve *A* was leaking. Getting a wrench, I tightened the gland. In doing so a little graphite and worn-out packing stuck to the wrench. To remove it I rapped lightly on the rim of the valve wheel. Instantly there was a sharp report, and in a second the space above the boilers was filled with steam. As I passed No. 3 valve I shut it and then covered the fires and put the feed on No. 1 boiler.

The side of the globe valve on No. 2 boiler had blown out and the escaping steam was directly in line with the stop valve of No. 1, which prevented cutting out that boiler.

Examining the break, which was about the size of a man's hand, we found that about three-fifths of the fracture was new. There were bypasses on the valves, but no other drains for the pipes above them. The valve was weak on that side, being 5/16 inch at the break and a little over ⅜ inch thick at other sections, which is rather light for a 6-inch valve.

Not having a spare valve, we put a brace under the elbow *B* and blanked the pipe with 5/16-inch steel plate where the



HOW THE BOILERS WERE CONNECTED UP

valve had been. The joint was well made and didn't leak, but a little after midnight the blank flange blew off. This time there were five distinct shocks of increasing strength. The fourth opened the joint a little, but not enough to prevent the next shock, which was very hard. One bolt pulled through a hole which was drilled a little large, another bolt broke, two bolts stripped the threads and the others held, the plate bending downward. We put a drip on the pipe, made repairs and had no more trouble.

FRANK EASTMAN.

Montpelier, Vt.

Bent Connecting Rods

The rod shown in Fig. 1 was on a high-speed compound engine running at 257 revolutions per minute. It was on the low-pressure side. The engine was hurriedly started and got a "dose of water." Although the rod was bent 1¼ inches out of line, the engine continued to run comparatively cool and quiet. This can

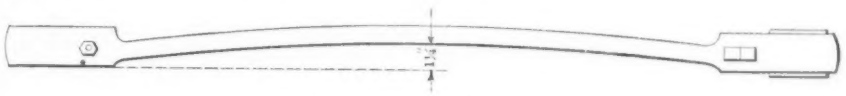


FIG. 1

only be accounted for by the fact that it had a large, strong crank pin, the surface of which was so great that the rod did not bind on the side, as it would have done on a small, weak pin. The cap plate

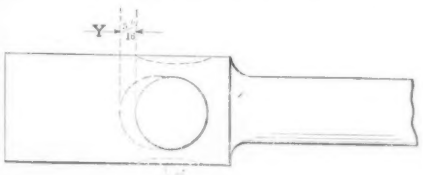


FIG. 3

being strong, helped the cause some, and the fact that the crosshead was heavy and well-fitting in the guides was also somewhat responsible for the action of the rod.

In Fig. 2 is shown the condition of another engine. The rod was of the flat type, very thin and wide in its section. This rod was bent on the edgewise section, contrary to all theory, and when inspected was found to be parallel on the side, the bend being downward toward the frame of the engine. This rod ran on without troubling the engineer. It was bent by water coming over into the cylinder and was due to starting too hurriedly. The above examples were of rods bent on the return stroke where the rods got a compression shock.

In Fig. 3 is shown a rod made with a wedge for taking up the brasses. The wedge hole was stretched as shown, the sides being drawn in at *E*, and pulled lengthwise 5/16 of an inch as at *Y*.

C. R. MCGAHEY.

Lynchburg, Va.

Production of Power from Producer Gas Plants

A report upon the production of power through the agency of producer-gas plants, made by the Hydro-Electric Power Commission, of Ontario, has just come to the writer's notice. It is so concise and brings out so many comparatively new points that I shall attempt to abstract parts of it, with the hope that the readers will find it profitable.

It is pointed out that producer plants are adaptable largely to those industries not requiring steam for heating and manufacturing purposes, and where gas can be profitably employed in brazing, annealing and similar work. From a user's viewpoint the saving in capital cost, reliability and simplicity of operation of hydroelectric and natural-gas power makes these effective competitors of producer gas, even at an excess cost of power developed by the former means.

The element of coal supply seems to

FIG. 2

enter largely in the selection of the different types of producer plant. The pressure or down-draft type of plant is deemed advisable only where a very large margin is obtainable between the cost of anthracite and bituminous coal. The margin, however, has to be quite large to make the above-stated types more advisable than the suction type using anthracite, as the latter uses less coal for the same useful work, requires less supervision and is a great deal more reliable in operation.

The suction producers can be operated on pea-size anthracite. This, however, does not appear to be definite, as no standard specifications prevail and the size for pea grade seems to vary with the dealer in cleanliness and size. Coke or charcoal may be used, but from 15 to 20 per cent. more by weight is required for a given amount of power.

The principal merits of producer plants are their small fuel consumption, at present the absence of restrictive regulations, and, to some extent, the lack of smoke nuisance. The lack of regulation is due to the lack of operating experience which allows restrictions to be drawn up. The number of poisonings and accidents due to the gas is increasing and it will be only a matter of time until a producer-gas plant will have to have a trained and certified attendant, such as is now required in a steam plant.

The greatest drawback the gas engine has, when compared to steam engine or electric motor, is its inability to take overloads. The full load is most economical, and efficiency falls off very rapidly at anything less, whereas a 20 per cent. overload will stop the engine. So on fluctuating loads, a 125- or, possibly, 150-horsepower gas engine will be required to handle the work that an 100-horsepower steam engine would take care of. However, for service similar to a pump working against a constant head, the gas-producer plant finds application.

The inability to start under a load is another very objectionable feature and the many difficulties developing therefrom cause frequent annoyance. Minor repairs and adjustments in steam units often only mean increased fuel consumption, whereas in gas plants it means refusal of operation until everything is accurately adjusted.

The commission looked into a considerable number of gas plants which had failed to operate satisfactorily and had been superseded by other power. The reason for the failure was due to one of the following causes:

"The power consumer being persuaded to install a producer-gas plant where this type is unsuited to the conditions of working.

"Failure of the selling agents to have the plant properly erected and satisfactorily put to work before handing it over to the purchaser.

"Failure of the selling agents and purchaser to arrange to have the attendant properly trained to work the producer-gas plant before he is left in charge. It is practically impossible for an untrained man to run a producer plant satisfactorily.

"Failure to obtain a suitable grade of coal for use in the producer.

"The power user often buys the cheapest plant offered without reference to its reliability or efficiency, or he attempts to run his plant on the cheapest coal or with the cheapest labor.

"Companies with no experience in producer or gas-engine work take contracts for installing plants which they have never before manufactured or experimented with. Their experiments are then carried on at the expense of the purchaser, usually to his dissatisfaction."

The report ends by stating that as compared with other prime movers the producer-gas unit is new and time should develop a machine whose reliability of

operation will allow it to cope with the steam engine and electric motor. To insure results the plant must be adaptable to the work which it is to do, and trained attendants furnished. With close precaution as to these points there is no reason why satisfactory results cannot be obtained.

F. H. NEELY.

Wilkinsburg, Penn.

Draining Steam Pipes

In almost every plant conditions exist in which we recognize an element of danger, but through constant association with it day after day, we soon regard it with complacence, if not with actual indifference. One case of this kind, which was very vividly impressed upon the writer, very nearly resulted in the death of the fireman. The boilers were connected to the header as shown in Fig. 1, so that when one boiler was cut out for any reason, quite a water pocket was formed on top of the stop valve, and when the boiler was cut in on the line again it was almost impossible, even with the utmost care, to avoid a water hammer in the pipes.

This condition was well known, and a drip had been provided for draining the branch pipes, it being the intention to connect these drips to a trap. Through neglect, the trap was never installed, and the custom was to drain the pipes by opening the globe valves in the drips by hand when a boiler was to be cut in, and it was nothing uncommon for a water hammer to occur when this was done.

On the day in question the fireman reported a boiler ready to cut in on the line, and he was instructed to do so, as was the custom. The engineer stood in the engine-room doorway watching him as he proceeded to the top of the boilers and opened the drip, to do which it was necessary to lean directly across the stop valve, with his entire weight upon it, and reach out at arm's length to the handwheel of the drip valve. As he opened this drip there was a sharp water hammer and he was enveloped in a cloud of steam, as though a gasket or the packing had blown out. He did not appear at all disturbed, however, and very calmly and slowly proceeded to open the stop valve, so the engineer naturally supposed nothing of consequence was wrong. When the fireman was asked what had happened, he said he thought the packing had blown out. Upon investigation, however, it was found that the valve was split from top to bottom, the only thing holding it together being the four 5/8-inch bolts, as shown in Fig. 2. Had this valve blown off, and it seems almost incredible that it did not, the fireman could not have escaped. When it was discovered that the valve was split, the engineer was confronted with the question of what was to be done. Whatever course of action he was to take must be taken quickly, for the valve was liable to blow off at any minute. It was out of the question to close it, and the only way to remove the pressure was to close the stop valves on all the other boilers, thus killing the header and shutting down the plant.

This was finally done, and the boiler on which the broken valve was located was blown out, the broken valve removed and the pipe plugged. After this accident the trap was immediately installed, and no further trouble from water hammer was experienced as the pipes were kept drained at all times.

This question of draining steam pipes rarely receives the consideration to which it is due, especially as it is such a simple matter to provide the necessary drips. Probably one of the cheapest and best methods, especially if the point to be drained is considerably above the water level of the boiler, is to return the condensation by gravity, as shown in Fig. 3. A stop valve should be provided at *A*, and a check at *B*. The return pipe should extend below the water level in the boiler.

The check is important, as it is quite possible at times to have a pressure in the header a few pounds less than that in the boiler, and in this event the water would back up into the header if it were not for the check, and considerable damage might result. A separate opening in the boiler should be provided for this drain, although it may be connected to the blowoff in case the boiler is not fed through this pipe.

In quite a large plant, the blowoff pipe was connected as shown in Fig. 4. It had been noticed for some time that the joint at *A* was leaking badly, and the pipe corroded and wasted away from this action. The engineer had been warned that the fireman was in danger of being scalded by the bursting of the pipe while blowing off the boiler, but as it was beyond the valve, where ordinarily there was no pressure, the matter was not thought to be of much importance, and the repairs were put off from day to day, until a serious accident occurred. The fireman had opened the valve and was standing with his hand on it awaiting the signal from the water tender to close it, when the

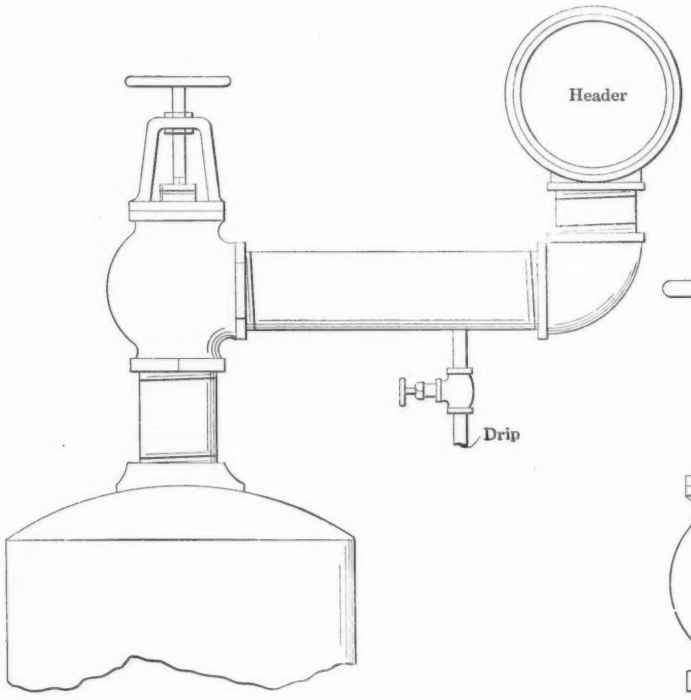


FIG. 1

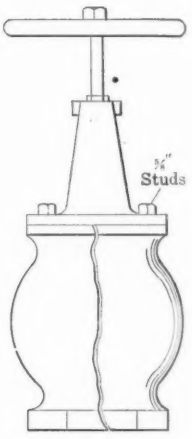


FIG. 2

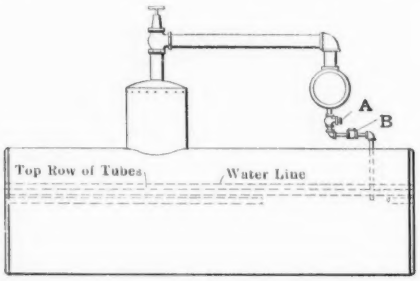


FIG. 3

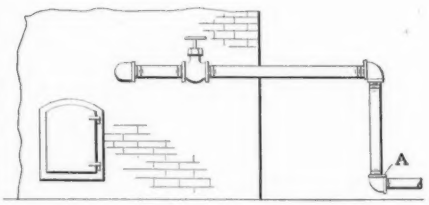


FIG. 4

corroded threads at *A* stripped and the force of the escaping water and steam threw the pipe up with great force, striking the fireman on the side of the head, breaking his jaw and fracturing his skull.

In a certain plant there was, among others, a large Corliss engine, and the attendant had a habit of allowing the pin to remain in place under the governor while the engine was in operation. The chief engineer was cautioned about this several times, and advised to install an automatic device. He considered it unnecessary, however, and issued orders, instead, that the pin be removed as soon as the engine was started. He was a very busy man, and did not see that his orders were obeyed. One day the governor belt broke while the pin was in place. Fortunately, the assistant engineer happened to be near, and shut down the engine before any very serious damage was done, though the engine was badly wrecked and extensive repairs were necessary.

M. KENNETT.

St. Louis, Mo.

Motor Operation

The first thing of importance to do when about to start a motor is to see that there is plenty of oil in the bearings, that the brushes make a good contact, that there is sufficient clearance between the armature and pole pieces, and to see that the armature bands have not worked loose, or that the end of a band is not sticking up so as to hit a pole piece.

Before starting a motor, see where the handle on the starting box is, and make sure that it is not in the running position. It is also important to see that there is sufficient oil in the bearings, and also that the oil rings work.

Any motor, regardless of make, if not located on a good foundation and in an accessible place, will in a short time give trouble. After a motor has been put in service the commutator should be looked over occasionally to see if any black bars are showing up; if so, it will probably be found due to a badly soldered lead. Another frequent cause of burned-out armatures is oil, as it softens the mica until finally the insulation between bars works loose, which causes shorts and heavy currents in the armature coil.

A motor should never be set down on a floor, because a small motor is hard to get at, and in case it is necessary to wash the floor, the field coils and armature are liable to get wet.

The armature should always have the proper clearance, which can be ascertained by using an air-gap gage made out of a piece of hardwood or iron, tapered down toward a point. About nine cases of trouble out of ten are caused by carelessness and uncleanliness.

C. R. STROTHERS.

Charlestown, W. Va.

Flywheel Accidents

Flywheel accidents do not all come from unavoidable causes. The writer has three in mind which could have been avoided by proper care.

Fig. 1 shows how a 15-foot flywheel went to pieces. A block of oak timber 6 inches square and 6 feet long had been left overhead in the engine room, where

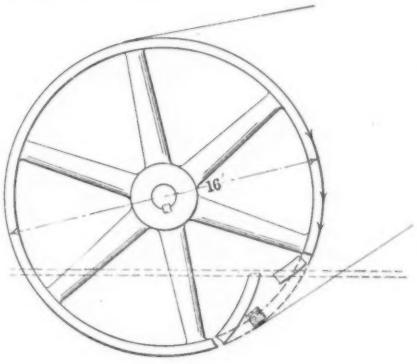


FIG. 1

it had been used to do some lifting. The vibration caused the timber to come down on the under side of the belt and, being caught by the foundation, caused the wheel to go to pieces, as shown. Another flywheel was ordered from the engine works, a gage measurement of the shaft being sent. The gage was made as shown

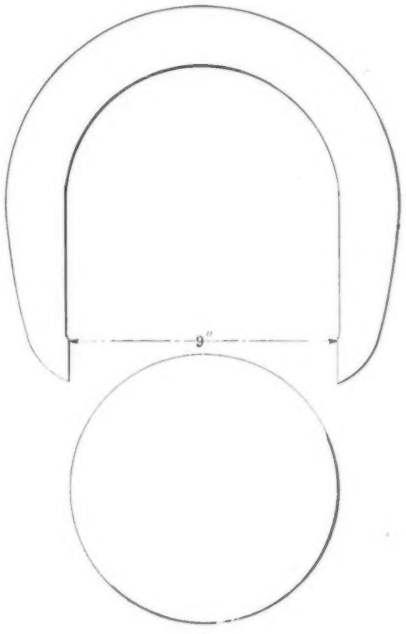


FIG. 2

in Fig. 2. By this method there can be no trouble in fitting a new flywheel to an old shaft.

In another instance the flywheel pit had no railing around it. One of the men engaged in erecting a steel stack stepped into the wheel pit and was killed. Not long ago a mechanic I was acquainted with stepped backward into a large flywheel pit and was killed. Some step should be taken to avoid such accidents, and more care should be exercised by those having unguarded wheel pits, the cost of protecting them being small.

C. R. MCGAHEY.

Lynchburg, Va.

Objectionable Features of Some Gas Producer Plants

There is a type of gas producer in use which is so troublesome to clean out that the job is dreaded by every person who is in any way connected with the operation. The ashes and clinkers to be removed are hot and as the loose ones are raked out they must be quenched by using a hose. The water thrown on them generates clouds of steam that carry the ashes into the eyes and nose and penetrate every opening in the clothing, as well as matting the hair and forming crusts around the lips and mouth. No amount of clothing will prevent the limbs and body becoming covered with lampblack, soot, ashes; even the shoes do not protect the feet from being also coated in the same manner. Numerous applications of soap and hot water are necessary to remove this greasy smudge. Every part of the producer room is covered, each projection of stone, brick or wood is a resting place for a pyramid of dust ready to topple over and again fill the air at the slightest jar or puff of wind. After the loose ashes and small clinkers are removed there still remains a quantity of larger clinker to be barred loose from the side walls and still larger and harder ones in the center of the generator which have to be broken up in order to remove them through doorway. This process of breaking requires long cold chisels and sledge hammers; the clinkers are still hot, and the holding of the chisel must be directed by looking through the doorway, requiring a crouching position, which men cannot maintain long at a time; consequently, the process is slow as well as laborious, and requires a number of men who work in shifts of a few minutes at a time. When this producer is finally emptied and ready to refire, a second one must receive the same attention.

This type of producer is built with a pair of generators to one boiler and scrubber. After the generators are cleaned the boiler must have its top removed and flue scrapers run through each flue, then openings near the bottom removed and all the soot and ashes which have been loosed or accumulated during the week's run must be cleaned out. Following this is the meanest job of all, the cleaning of the traps on the gas line between the scrubbers and the gas holder. A new man must be provided at each cleaning to perform this operation. No man will do it the second time; he will quit the job first. It consists in getting

down into a pit almost entirely filled with soot or lampblack and shoveling out this material, which is part dry and part wet. The dry portion is very light and floats around, filling the air. It must be carried to the lungs with every breath, inhaled and sticking like glue when moistened. The man who performs this job is a walking paint factory for the next week.

Cleaning out is a regular necessary weekly performance, usually done on Sunday, as it takes all day with eight men and a superintendent. Any good fuel drawn out with the ashes is saved and used in starting new fires. This is a down-draft type of producer using bituminous coal, and when making producer gas it is worked with the top open, as no steam is admitted with the air. The inclination to clinker is intensified, especially when no attempt is made by the operator to keep the top of the fire bed leveled off, or to stop the draft holes through it. When asked why, one of these operators replied: "The top is all caked, and if I stop that hole I will have to make another to let the air pass through."

I visited a plant of this kind two days in succession, and was then invited to come on Sunday and see a clean out. Securing some old clothing proper for the occasion, I arrived at the works on time. They started cleaning at 8:30 in the morning, with a half hour rest at noon. The work was completed and new fires started at 5:30 in the afternoon. The best possible wash up at the plant after the work was finished was made, and this left me about as presentable as a coal passer just out of the stoke hole. The chief operator, who had superintended the work and handled his men well, making every move count, said each weekly operation varied little, if any, from the one witnessed.

A suction gas-producer plant, intended to furnish gas for heating and furnace work, as well as to supply gas engines, was installed with the engine and exhauster taking gas from the same pipe openings at the dry scrubber, the exhauster delivering the gas to the heating system. When both were started at the same time and the quantity of gas each consumed did not vary much, the arrangement seemed to work fairly well, but the moment extreme variations occurred in either service, the other was affected; the engine would miss explosions and slow down or the furnace gas would lose its ignition and this would be followed by an explosion. The erecting engineer insisted that the connections were proper, and while he was in charge, seemed to manipulate it fairly well, the engine losing its suction only a few times, when the quick throwing of the switch and stopping the motor driving the exhauster prevented a shutdown of the engine. The regular operator, however, had extreme trouble in keeping the two working simultaneously. After several stoppages a consulting engineer was called in to decide how to correct the difficulty. He recommended changing the plant from a suction to an induced draft, putting the supply pipe to the engine as well as that to the heating service pipe on the pressure side of the exhauster, but the exhauster was not of sufficient size to handle the volume of gas necessary for both, so a new opening was made to the dry scrubber on the opposite side from the outlet pipe to the engine. This has corrected the trouble to a certain extent, but not entirely. While the fire in the producer is in good condition, both services get all the gas required, but any severe change in the fire conditions still causes a see-sawing of the two sources of demand. The owner says that as soon as the normal demands on factory return a large exhauster will be installed and the entire plant put on induced-draft process.

T. F. CHRISTOPHER.

Philadelphia, Penn.

Combustion or Total Heat Formulas

Some time ago I became interested in buying coal on the heat-unit basis, and consequently was very glad to see the discussion under the above heading in the August 11 and October 13 numbers. I am inclined to think that an estimation can be made from the proximate analysis that will come within 3 per cent., on most American coals, of a heating value above 11,000 B.t.u., and most of our most prolific beds average well above this figure.

As a matter of interest, I took twenty-five analyses, representing almost every district from *Professional*, the paper (No. 48) got out by the Government, pertaining to the coal tests carried on at St. Louis, and plotted a set of curves, shown in Fig. 1, between the actual heating value in B.t.u. and the various percentages of the approximate analysis. These are curves 1, 2, 3 and 4, and from them it is easily seen that the fixed carbon bears no direct relation in itself to the heating value. Finally, however, I tried a curve of the sum of the fixed carbon and the volatile matter. The result is shown in curve 5. It will be seen that this curve has somewhat of a regular slope and rises rather regularly as the heating values go up. So regular, in fact, that I ventured a straight line *A B*, which coincides remarkably well with the original curve from 11,000 B.t.u. up.

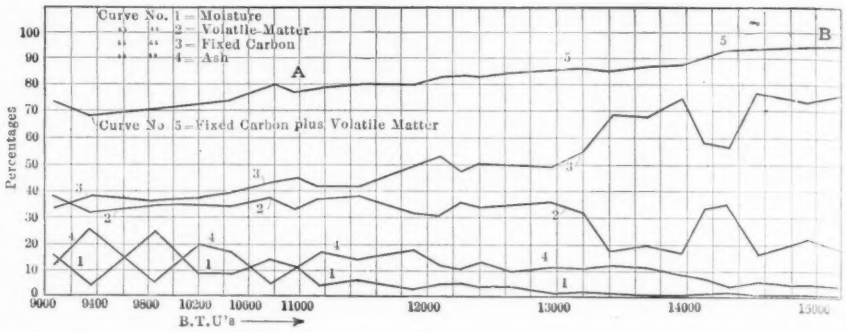


FIG. 1

Now, as most of our coals are above this value, I reckoned as to how close this curve method would give the heat value. The result is shown in Fig. 2, which is the straight line of Fig. 1 drawn to a larger scale for more accurate reading.

Referring again to the Government tests, I tried out thirty cases by the curve. To my surprise the average error was only 1.53 per cent., with nine cases under 0.05 per cent., twelve cases between 1 per cent. and 2 per cent. of error, ten cases from 2 per cent. to 3.4 per cent., and one of 4.2 per cent., which is quite accurate for this class of work.

FIG. 2

Referring, now, to the analysis cited in the August 11 number, the sum of the fixed carbon and volatile matter is 92.6 per cent., which, when applied to the curve, Fig. 2, gives a heating value of 14,590 B.t.u., this being an error of only 2.6 per cent., whereas the nearest estimate given by Mr. Coes is 3.3 per cent. This shows the curve to be of some use in estimating heating value from approximate analysis.

A very close estimation can be made by the help of a table in Kent's handbook, which that author has developed from a study of Mahler's tests. It is as follows:

Percentage F. C. in Coal Dry and Free From Ash.	Heating Value B.t.u. Per Lb. Combustible.	Percentage F. C. in Coal Dry and Free From Ash.	Heating Value B.t.u. Per Lb. Combustible.
100	14,500	68	15,480
97	14,760	63	15,120
94	15,120	60	14,580
90	15,480	57	14,040
87	15,660	54	13,320
80	15,840	51	12,600
72	15,660	50	12,240

Below 50 per cent. the law of decrease of heating power shown in the table apparently does not hold, as some cannel coals and lignites show much higher heating power than would be predicted from their chemical constitution.

The use of this table may be shown as follows:

Given a coal containing moisture 2 per cent., ash 8 per cent., fixed carbon 61 per cent., and volatile matter 29 per cent., what is its probable heating value? Deducting moisture and ash, we find the fixed carbon is 61/90 or 68 per cent. of the total of fixed carbon and volatile matter. One pound of the coal dry and free from ash would, by the table, have a heating value of 15,480 B.t.u., but as the ash and moisture, which have no heating value, are 10 per cent. of the total weight of the coal, the coal would have 90 per cent. of the table value, or 13,932 B.t.u.

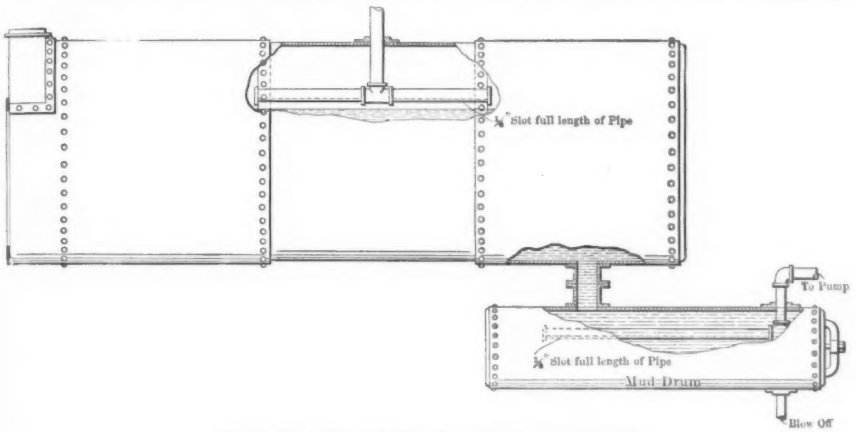
By using this table on ten cases of the Government analyses, I found an average error of only 1.09 per cent., with a maximum of 2.96 per cent. and a minimum of 0.067 per cent.

F. H. NEELY.

Wilkinsburg, Penn.

Arrangement for Distributing Feed Water

I find that a ¼-inch slot in the distributing pipe having an area a little greater than the feed-pipe inlet, answers our purpose very well. We have a 1½-inch feed pipe for each boiler, and are feeding into a mud drum. The area of the slots in the pipes is 7 square inches, the slot being on the bottom of the pipe. The illustration shows the feed-pipe connections to the boiler and also the mud drum. In case no mud drum is used, direct feed may be employed. When feeding into the mud drum the feed-pipe connections in the boiler are eliminated.



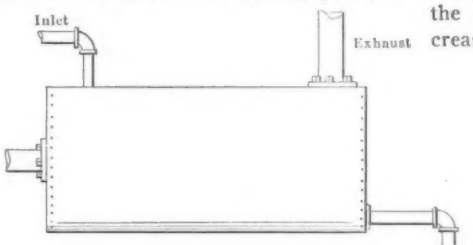
ARRANGEMENT FOR DISTRIBUTING FEED WATER

F. C. DONATH.

Winona, Minn.

Pumping Hot Water

In many new power plants open-type heaters are used, and consequently the water is brought to the boiling point, in many cases steam being generated, making it no easy matter to handle the water. When handling hot water the pump should be placed below the heater so the water will flow to the pump, as shown in the illustration, thus keeping the pump constantly primed.



In the discharge pipe I place an auxiliary air chamber. This is made of a tee, a short piece of pipe and a piece of 4-inch pipe, capped, the lower cap being tapped for the small pipe, as shown. An air valve should be placed in the top cap. If a pump gives trouble by hammering, close the valve *E* a little, and the steam in the water will not bind the pump. When pumping into two boilers, the same regulation can be obtained by simply regulating the valves in the feed line next to the boiler. The reason is this: Steam is admitted to the steam end and starts the plunger, and the opposite end being cushioned with an elastic body tends to quicken the movement of the plunger and throw it violently against the end of the pump. Closing the valve between the pump and the boiler throws more pressure against the pump plunger and causes a constant pressure in the feed line.

C. R. MCGAHEY.

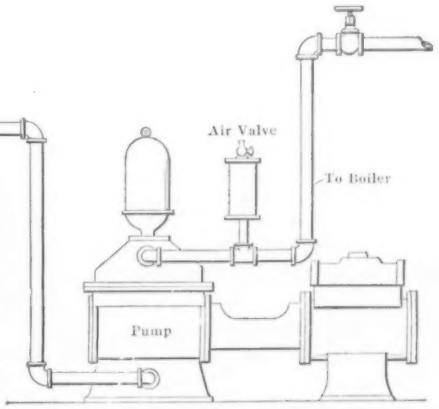
Lynchburg, Va.

A Motor Trouble

While visiting the power plant of a paper mill the other day, the chief engineer gave me a puzzle to solve, and not being an electrician, I "pass it along."

There are two General Electric compound-wound direct-connected generators of 250 kilowatts each. One is run as a motor and the other as a generator connected to a 300-horsepower water wheel. The two machines are about ½ mile apart. There is also a 300-horsepower engine. Sometimes the motor alone is used.

One man goes to the wheel house and opens up the gate on the water wheel until the generator is up to speed and the voltage reaches 500 volts. Then the man at the mill starts the motor, and when it is up to speed, throws in the shaft clutch; but to prevent stalling the motor the clutch is thrown in and out until the shaft gets up to speed. In one instance, just as the shaft got up to speed, a workman started one of the large beaters and brought the shaft to a standstill. To prevent stopping the motor with the current on, he threw out the clutch. The motor stopped just the same and started off in the opposite direction at a greatly increased speed, throwing streams of fire from the brushes. Of course, the man pulled the switch. The machine then started without getting stalled, and everything was all right except the instruments, which were reversed.



THE PUMP BELOW THE HEATER

THOMAS SHEEHAN.

Pittsfield, Mass.

Gas Power Section of the A. S. M. E.

Papers Presented: High and Low Heat Values; Reminiscences of a Gas Engine Designer; Some Possibilities of the Gasolene Turbine

At the annual meeting of the American Society of Mechanical Engineers, from December 1 to 4, the usual separate session of the Gas Power Section was held. The first technical matter presented was a written discussion by Prof. Lionel S. Marks of the question of high- *versus* low-heat values of gases used in engines.

High- and Low-heat Values

Professor Marks pointed out that in some discussions the terms "lower" heat value and "effective" heat value have been used as synonymous, and that the two words have definite and different meanings in German practice. "Effective" heat value in Germany is the heat value of unit volume of gas under the conditions of pressure and temperature at which the gas is used; as thus defined it is a useful quantity and no other name is used for that quantity. "Effective" heat values can, of course, be either "high" or "low" heat values. The low-heat values, he thought, give the better basis from which to measure the relative efficiencies of different gas engines. There is, however, some divergence in practice in the method of computing lower heat values. Many engineers find the lower heat value of a gas by subtracting from the high-heat value (as determined by the Junker calorimeter) the latent heat, at atmospheric pressure, of the steam that is formed by the combustion. The British Institution of Civil Engineers code of rules defines the low-heat value as the heat left after subtracting from the high-heat value the total heat of steam at atmospheric pressure, measured above water at 32 degrees Fahrenheit. The Verein deutscher Ingenieure takes as the low-heat value the heat which is liberated by the complete combustion of the fuel when the products of combustion are cooled down to the original room temperature at constant pressure, it being assumed that all moisture present remains in the form of a vapor. Professor Marks considers, however, that there is only one low-heat value which is logical. The use of the low value is based upon the knowledge that at the temperatures existing in gas-engine cylinders the working substance is a mixture of gases and highly superheated vapors. The fact that water vapor, after leaving the cylinder, condenses and, therefore, gives up more heat than would be the case if it remained a vapor, does not help the engine at all. Two exactly similar engines using fuels which differ only in the matter of condensability after leaving the cylinder ought to show the same efficiency on the low-heat basis. They will do so only if the low-heat value is calculated on the assumption that the water vapor remains a vapor down to the room temperature.

It is probable that the water vapor never forms as much as 15 per cent. by volume of the products of combustion; that is, its pressure is not more than 2.2 pounds per square inch. This corresponds to a saturation temperature of 130 degrees Fahrenheit. Condensation of the water vapor would not begin, therefore, until the temperature of the products of combustion (at atmospheric pressure) fell to 130 degrees Fahrenheit.

Where great accuracy is required it should not be forgotten that the Junker calorimeter does not give the real high-heat value except when the air and the gas are saturated with water vapor, when the products of combustion escape at the temperature of the room and when there is no contraction in volume. The importance of the correction for the nonrealization of these conditions is evidenced by the fact that the operation of a Junker

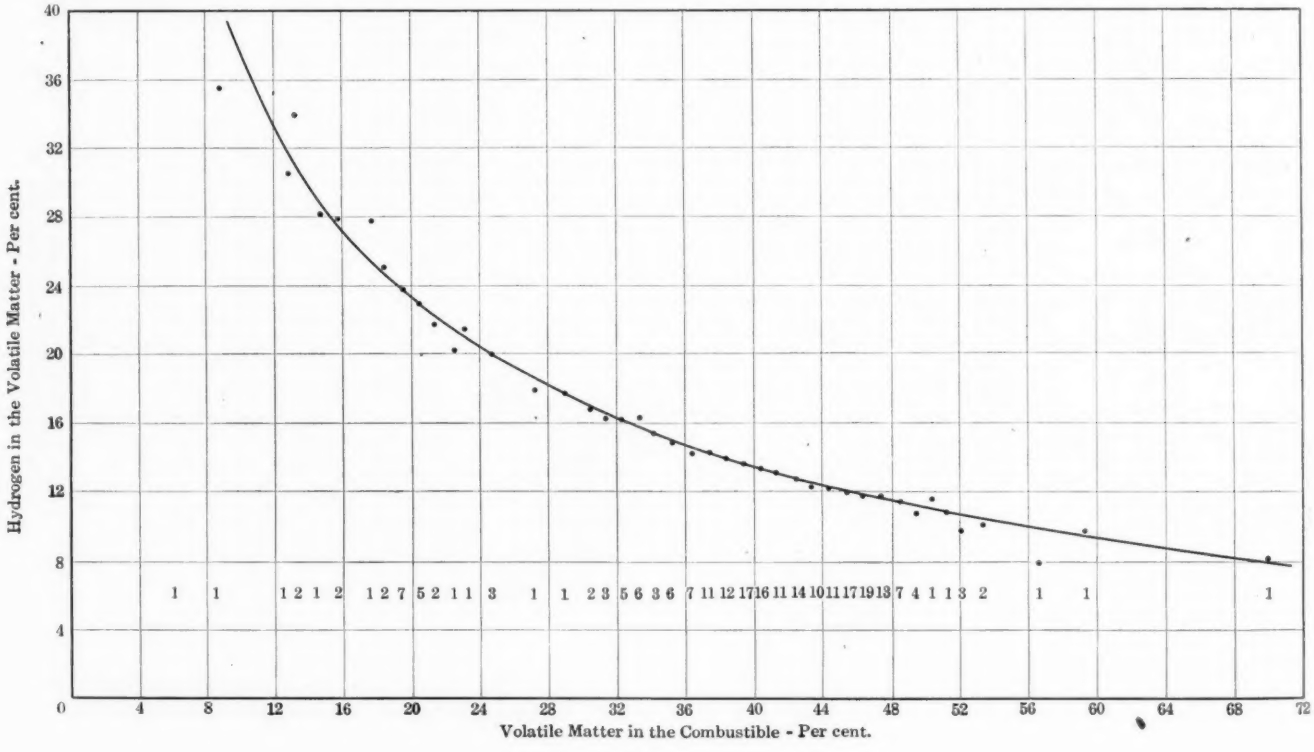


FIG. 2

calorimeter with producer gas very often gives no condensation water; that is, that the calorimeter in that case is giving low-heat values. The correction is rather troublesome, as it requires the analysis not only of the gas but also of the products of combustion coming from the calorimeter. From these analyses the relative volumes of air, gas and products of combustion can be determined, and if the humidity of the air and gas are also known the weight of uncondensed vapor escaping into the products of combustion can be determined.

If the efficiency of a producer is to be determined on a low-heat basis the hydrogen content of the coal must be known. This quantity can be determined experimentally only by carrying out the ultimate analysis of the coal, an analysis which is best made by a chemist. Professor Marks called attention to his investigation of an apparent relation between the amount of volatile combustible matter in coal and the hydrogen content.* The results of this investigation show that for the fuels occurring in the United States it is possible to determine the hydrogen content of the coal from the proximate analysis alone with an accuracy that is sufficient for all practical purposes. Of 240 fuels analyzed from every part of the United States, and of every kind from a graphite anthracite to peat, one fuel only (a graphite anthracite from Rhode Island with 6 per cent. of volatile combustible) shows a hydrogen content differing by more than a negligible amount from that indicated by the proximate analysis.

In Fig. 1 [omitted here—Eds.] are shown points representing the percentage of volatile matter in the combustible, and the hydrogen content of that volatile matter for each of the 240 fuels of which analyses have been made and published by the United States Government during the past four years. Many of these points are superposed. They represent solid fuels containing from 6 to 70 per cent. volatile matter. To plot the relation in a curve satisfactorily, the average position of the points was calculated for each 1 per cent. of volatile matter, and these average points are given in Fig. 2 [see page 1012]. The number below each point is the number of fuels of which it is the average. The maximum difference between the curve and the individual points, with less than 48 per cent. of volatiles, represents a possible error of ½ per cent. in the determination of the hydrogen in the coal. Above 48 per cent. (that is, with lignite and peat) there is a possibility of an error of 1 per cent. in the determination of the hydrogen of the fuel from the curve. One per cent. error in the hydrogen is equivalent to about seven-tenths of 1 per cent. error in the determination of the low-heat value of a fuel. This is the limit of error by the use of the curve in Fig. 2 when lignite or peat is being used. For ordinary bituminous coal or anthracite the limit of error is about three-tenths of 1 per cent. The probability of error for fuels which are neither extremely high nor extremely low in volatile matter is not more than one-tenth of 1 per cent.

The following table gives the percentage of hydrogen in the combustible matter corresponding to various percentages of volatile matter in the combustible:

Per Cent. of Volatile.	Per Cent. of Hydrogen.
10	3.4
12	3.8
14	4.1
16	4.3
18	4.5
20	4.65
22	4.8
24	4.9
26	4.98
28	5.05
30	5.12
32	5.17
34	5.22
36	5.27
38	5.31
40	5.35
42	5.39
44	5.42
46	5.45
48	5.47
50	5.49
52	5.5
54	5.53
56	5.55
58	5.57
60	5.59
62	5.61
64	5.63
66	5.65
68	5.66
70	5 67

*Power and The Engineer, December 1, 1908.

Reminiscences of a Gas-engine Designer

The above subheading is the title of a paper read before the Gas Power Section at the annual meeting, December 1 to 4, by L. H. Nash. The paper makes rather interesting reading, especially for young designers who are likely to waste much time on some of the experimentation that Mr. Nash went through with. The author described his early efforts in the direction of a gas engine intended to operate on the modified Lenoir cycle described in January, 1907, by J. T. Milton, before the English Institution of Civil Engineers, and suggested by Dugald Clerk thirty years ago, a high-pressure engine equipped with a clumsy linkage between the pistons and the crank pin, and one or two other types which embodied more ingenuity than engineering. The most interesting, because most practical, of these various designs was a two-stroke engine with crank-case compression, almost exactly like the two-port boat engines of that class—which are so widely used today. The data of this invention are not given, but from the reference to it in the paper the impression is gained that it antedated the earliest claim hitherto put on record.

The idea of a combined gas and steam engine also occurred to Mr. Nash many years ago, but his effort to patent it was defeated by records of English patents covering every conceivable phase of such a combination. Although this was many years ago, the combined gas and steam unit has not yet been built commercially, but Mr. Nash attributes that to the fact that the extra expense would not be justified by the heat saved in small units, and large units are of comparatively recent date.

Concerning ignition, the author stated that his experience had shown that with a good strong spark even a weak mixture may be ignited reliably and quickly; the practice of advancing the time of ignition he considered unnecessary.

Some Possibilities of the Gasolene Turbine

A paper by Frank C. Wagner bore the above attractive title, but it was so largely mathematical as to defy analysis by inspection or anything like an intelligible abstracting in words. The object of the paper was to present a theoretical comparison between the efficiencies of a turbine in which the temperatures would be kept down by excess of air, and one in which water injection would be used for that purpose, the cycle being that proposed by Brayton for reciprocating engines. The conclusions were rather indefinite, but as the whole process of comparison was entirely academic, that might reasonably be expected. Professor Wagner's mathematical analysis indicated that the relative efficiencies of the two methods depends upon the degree of precompression employed and upon the efficiency of the compressor. The accompanying table gives a few of his results. In his computations the air allowed per pound of gasolene was 19 pounds with water injection; 34 pounds with 27 compressions and interstage cooling; 47 pounds with 27 compressions and no cooling; 43 pounds with 16 compressions and interstage cooling; 52

SOME OF PROF. WAGNER'S FIGURES FOR TOTAL EFFICIENCY, BASED ON A TURBINE EFFICIENCY OF — PER CENT.

Compressor Efficiency.	Two-stage Compression to 16 Times the Initial Pressure.			Three-stage Compression to 27 Times the Initial Pressure.		
	No Interstage Cooling.	Interstage Cooling.	Water Injection.	No Interstage Cooling.	Interstage Cooling.	Water Injection.
70%	9%	15%	16%	10%	21%	16%
80%	15%	21%	19%	18%	25%	20%
90%	20%	24%	21%	24%	29%	23%

pounds with 16 compressions and no cooling.

In a written discussion submitted by Sanford A. Moss it was pointed out that lack of knowledge of specific heats, densities and dissociation necessitates certain assumptions which render uncertain any computed temperature and efficiency values.

The officers of the section elected for the ensuing year are F. R. Low, president; George A. Orrok, secretary; F. H. Stillman, George I. Rockwood, R. H. Fernald, F. R. Hutton, H. H. Suplee, executive committee. The chairman of the membership committee is R. T. Lozier; the chairman of the meetings committee is Cecil P. Poole.

The retiring executive committee recommended the appointment of a nominating committee, to place at least two candidates in nomination for each office; a committee on installations, to keep up a list of all gas-power plants, giving complete data as to the equipment; a committee on plant operation, to collect and record information as to load characteristics, costs of operation, behavior of apparatus, etc., and a committee on breakdowns, failures, etc., to collect and file information relating to accidents, unsatisfactory performance, and so on.

The Mechanical Engineers

The annual meeting of the American Society of Mechanical Engineers was held at the Engineering Societies' building, New York, December 1 to 4, inclusive. The address of the retiring president, M. L. Holman, dealt with "The Conservation Idea as Applied to the American Society of Mechanical Engineers." He began with a reference to President Roosevelt's meeting with the governors last winter, and said that the President ascribed to the action of the Engineering Societies the credit of inaugurating the conservation campaign on nonpolitical lines. After a study of the growth and distribution of the population, Mr. Holman dealt extensively with Health, Food, Land, The Forests, Water, Coal and Mineral Resources. It is in his treatment of power, both from water and coal, that the address finds its direct application to our field.

Mr. Wilson, of the United States Geological Survey, estimates that our present rate of increase in the consumption of coal indicates that our supply will be exhausted in about two hundred years. Future observations may prove that we are drawing conclusions from insufficient data obtained at the peak of the curve. We now realize that the conclusions of a Conference on the Conservation of Whales, had one taken place in New Bedford some years ago, would have created unnecessary alarm and expense. While whales were an important item in that day and generation, the present civilization does not need them. Just as long as it pays to work a mine for the best coal only, this process will continue, and the future will have to take care of itself. Which one of you, as householder or engineer, will put up with a poor run of coal in order that posterity may have good coal? The departments of our Government demand the best grade and are not willing to take the "run of the mine." This means that the poor grades are pushed on smaller purchasers or "go over the dump." If the Government wishes to set an example in the conservation of the coal supply, let an effort be made to adjust the power plants and heating plants at Washington to burn low-grade fuel. The gas engine and gas producer give promise of a large saving in coal, but there are still some "bugs" to be got out of the apparatus. As applied to blast-furnace work and for running on natural gas, the gas engine is giving results that indicate its ultimate success. In furnace work the gas engine uses about 40 per cent. of the blast-furnace gas consumed under boilers supplying steam to a first-class steam-blowing engine in the same capacity.

In designing plants with a high labor and low material market, the engineer often finds the power plant which will produce a horsepower-hour with the smallest coal consumption to be the most expensive plant under operating conditions. I have in mind, from my personal experience, two illustrations of this. In one case a power plant and arrangement of machinery were used that would make the graduate mechanical engineer just from school smile in derision, and in the other case the power plant put in at the request of the owner, who expressed a desire to assist in the improvement of the general state of the art, would delight the heart of a professor of thermodynamics. The relative amount of coal per horsepower in the two plants was about 4 to 1, yet the plant which used five pounds of coal per horsepower caused competitors to consolidate for the purpose of reducing expenses, while the plant which could use 1¼ pounds of coal per horsepower fulfilled the desire of the owner who is still contributing to the advancement of the arts and boasting of coal economy. It would not surprise me, however, to get an order at any time to put in a steam plant and dump the gas plant in the scrap heap.

The author sums up a consideration of the small percentage of the heat units contained in the fuel which are convertible into work with the observation: "If our ecclesiastical brethren maintain that the storage of coal is a manifestation of divine providence, the present inventions for utilizing it must have emanated from his satanic majesty. It is quite safe to assume that with our present methods, we cannot expect more than 15 per cent. of the heat value of the coal to be converted into work in the power house. With an efficiency of distribution of 56 to 67 per cent., which, by the way, is good practice, we may get 10 per cent. of the total energy of the coal to the consumer; that is, applied with an efficiency of 75 per cent., the consumer realizes but 7½ per cent. of the stored energy of the coal. This is good engineering practice at present and it is sad to say that but few plants are doing as well. In using electricity for lighting, we get less than 1 per cent. of the heat value of the coal as used for light.

The producer plant and boiler plant are practically equal, as far as the first step in converting the coal into power is concerned. The average gas engine is more efficient than the average steam engine, but the best gas engines and the best steam engines are about equally efficient. The city of St. Louis replaced pumping engines that were in first-class running order with high-duty pumping engines that reduced the coal bills about 75 per cent., but this was not done to conserve the Illinois coalfields for the next generation. It was good engineering under the load conditions of a large pumping station, but in many power plants the installation of the triple- or quadruple-expansion engine, while saving coal, would increase the cost of the output. I mention this case in order to impress on the rising generation of engineers that interest on first cost must be given due weight in designing plants in order to insure success.

In 1820 there were 6.9 pounds of coal consumed per capita per year. In 1900, 7496.8 pounds. If the rate at present indicated continues, the total coal supply of the country will be exhausted in about one hundred years. It is not probable, however, that this rate will continue, but that the curve will reach a maximum and then slowly recede as the end of the coal approaches or a substitute is found or something else happens. Prognostications based on the assumption that the population of the coal-consumption curve will continue along the paths of the past 40 years must be introduced with a big IF.

There seems to be a hypnotic power attached to hydraulic-power schemes that causes promoters and investors to lose sight of the fact that the real criterion is fixed charges *versus* operating expenses. In locations such as the Pacific coast, with coal at about $14 per ton, the hydroelectric plant finds its true habitat, but in the vicinity of coal mines where cheap fuel prevails, the steam-driven plant is the present solution. As far as the conservation of water power is concerned, much may be said, but the problem, involving as it does the fundamental question of ownership by the individual, the State or the nation, and the further legal question of riparian rights, as opposed to appropriation, is one that will require much

study and many legal battles to solve. The question involved is one of ownership and the real conservation will be effected by legislation that will protect the public from the loss of valuable rights.

The improvement in long-distance transmission from the ten miles of ten years ago to the two hundred miles of today makes water power available over large districts. In California, four power companies with an aggregate capital of some $50,000,000 control thirty hydroelectric and steam-power plants. In the entire State about 250,000 horsepower is in operation under private control. Mr. Lindsay states that there is a potential development of 800,000 horsepower on four rivers in the northern part of California that are under private control and that but 20,000 is utilized, the balance being tied up by speculative interests. Heretofore, Congress has required no compensation for water-power grants and during the past ten years has handed over to promoters and speculators thirty-three such grants gratis. The same authority states that of about 16,000,000 horsepower now in use in the United States less than one-quarter is from water power and 1,600,000 horsepower is going to waste over Government dams. The total water horsepower available for immediate use is given as 12,000,000.

On Tuesday and Wednesday evenings occurred two notable lectures, the attendance upon which taxed the capacity of the large auditorium. The first of these was by Prof. John A. Brashear, upon "Photography of the Stars," the lecture following upon the conferring of an honorary membership upon the lecturer. On Wednesday evening, Lieut. Frank C. Lahm, a member of the Aëronautical Board of the Signal Corps of the United States Army, who has for many years experimented with dirigible balloons for war purposes, and has participated in several international balloon races, winning the James Gordon Bennett cup in 1906, taking part in the experiments at St. Louis and making ascensions with Orville Wright, at Fort Myer, Va., lectured upon "Aëronautics." Both lectures were illustrated with lantern slides, the latter with moving pictures of the balloons and flying machines in motion.

Thursday evening was devoted to the usual reception.

The officers elected for the ensuing year are: President, Jesse M. Smith; vice-presidents, George M. Bond, R. C. Carpenter, F. M. Whyte; managers, H. L. Gantt, I. W. Moultrop, W. J. Sando; treasurer, William H. Wiley.

Such of the papers as are of particular interest in our field will be found in other columns and issues.

Direct Current Motors

By R. H. Fenkhausen

Direct-current constant-potential motors may be divided into four classes as regards speed: constant speed, multispeed, adjustable speed and varying speed. This is the classification adopted by the American Institute of Electrical Engineers. The constant-speed class embraces all motors running at a practically constant speed and those which vary only a few per cent. from no load to full load. The shunt-wound and differential-compound motors are of this class. The multispeed motor is one which can be operated at any one of a few distinct speeds, such as the shunt-wound motor with two armature windings and commutators, which can be operated at either of two speeds. The adjustable-speed motor is one the speed of which may be gradually varied over a wide range, for example, by an adjustable resistance in the armature circuit or one in the shunt-field circuit. These motors are usually either shunt-wound or interpole machines.

The varying-speed motor may be either series or compound wound, but it is usually the former, and its speed regulation is effected by adjusting a resistance in the armature circuit, but it varies with every change of load, as will be explained later.

Direct-current constant-potential motors may also be divided into classes with regard to field winding: shunt-wound, series-wound, compound-wound, differential and interpole. The field winding of a series-wound motor (Fig. 1) is of heavy wire which carries the full current of the armature, and as the armature current varies with the load, the field strength varies also, resulting in variation of speed inversely with the load. It therefore follows that the series-wound motor is especially well adapted to carrying heavy intermittent loads, as in hoisting or railway work. Series-wound motors are not usually rated in horsepower, but are given a number which refers to some performance curve supplied by the maker. The reason for this is that the motor can carry enormous overloads for short periods, owing to its powerful torque at reduced speeds. A nominal horsepower rating is often given, however; it is based on a one-hour run with a given temperature rise.

Owing to its varying-speed characteristic the series-wound motor must always be geared or direct-connected to its load, never belted, because in case of a broken belt the motor would rapidly accelerate its speed until destroyed by centrifugal force. This action may be explained as follows: Assume a given load on a series motor, with a certain speed, current and field strength. If the load is suddenly removed the speed immediately increases and the current is therefore reduced to a small fraction of its former value, weakening the field to such an extent that the armature must revolve at an enormously increased speed to generate the required counter-electromotive force; this causes a further decrease in current and corresponding increase in speed, and so on and on until a point is reached where the mechanical energy necessary to revolve the armature equals the electrical input, at which point the speed becomes constant. The motor would be destroyed long before this speed was reached. The field-magnet coils of the shunt-wound motor (Fig. 2) are wound with fine wire and the winding receives the full line voltage; consequently, the field strength is constant after the coils have attained working temperature. As the resistance of copper wire increases with the temperature, the field winding of a shunt-wound constant-potential motor will take slightly less current when warm than when cold; consequently, the field strength will be slightly reduced and the armature speed correspondingly increased, when warm. Although the field strength of a shunt-wound motor is constant after it attains working temperature, the speed varies slightly from no load to full load, because of the loss due to the resistance of the armature circuit; at no load the counter-electromotive force is almost equal to

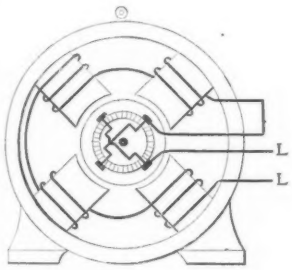


FIG. 1.

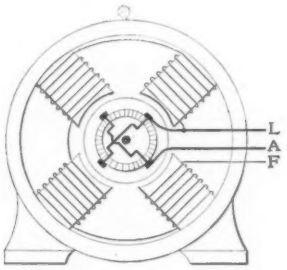


FIG. 2.

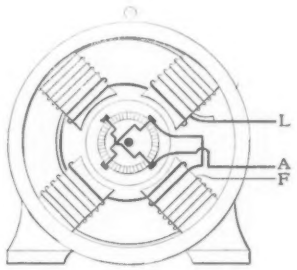


FIG. 3.

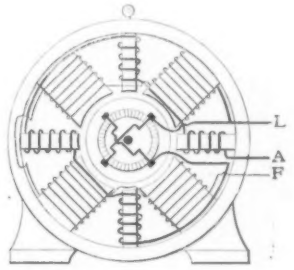


FIG. 4.

the impressed voltage because the armature current, and therefore the voltage drop across the armature resistance, are negligible. At full load the voltage required to force the armature current through is considerably greater; consequently, the counter-electromotive force, and therefore the speed, are necessarily reduced.

The compound-wound motor is a combination of the shunt and series types, both shunt- and series-field windings being used on this motor. Either the shunt or the series winding may be the stronger at full load, in a straight compound winding. The two windings, however, may be connected either to assist or to oppose each other, depending on the service to which the motor is applied; when they are in opposition, the series winding is always the weaker.

Some motors which are liable to lose their load are supplied with a series winding to supply the normal excitation and a light shunt winding called a "restraining" shunt, to prevent dangerous racing.

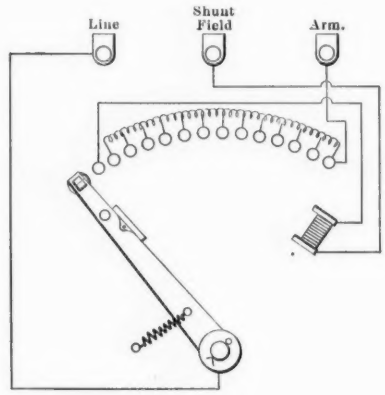


FIG. 5

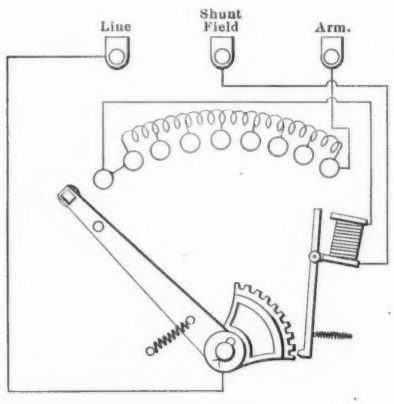


FIG. 6

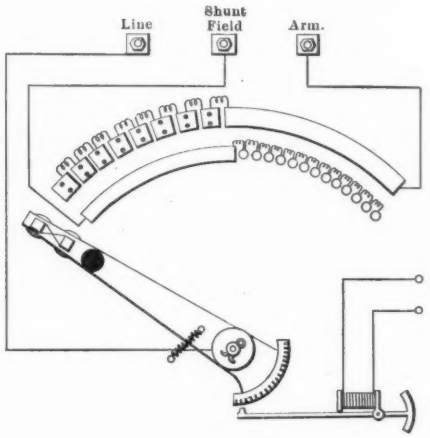


FIG. 7

The series coils do most of the magnetizing, but in case the load is dropped the shunt winding prevents the armature speed from reaching a dangerous rate. Just the opposite arrangement applies when a motor is wanted to run at a practically constant speed, but has not sufficient starting torque. Then the shunt winding is the stronger and principal one, supplying most of the magnetism, but a light series winding is provided and the heavy starting current flowing through this gives a very strong field and resulting heavy torque at starting. After the motor is running the series field may be short-circuited if desired.

In both of the foregoing cases the field windings are connected cumulatively, but sometimes they are so connected as to oppose each other, in which case the motor becomes differentially compounded and its speed will increase with the load. There is little need for a motor of this type. One use of the differential winding is to make a motor run at an absolutely constant speed. The small speed variation characteristic of the shunt-wound motor is corrected by using a very weak series-field winding opposing the shunt winding; the increase in the voltage drop in the armature with increasing load is offset by the current in the series winding weaken the main field just enough to increase the armature speed to its normal value.

Any of the types of motor thus far discussed may be also of the interpolar type (Fig. 4). In such machines small magnet poles are set in between the main poles and equipped with a winding in series with the armature. These auxiliary poles are located over the no-load neutral points of the armature and serve to prevent the armature reaction from shifting the magnetic field away from the neutral points under varying loads. This permits uniform commutation at all loads and prevents sparking and excessive heating of the commutator. The greatest field for these motors is in service where varying or adjustable speed is required. For a given service an interpole motor is smaller and lighter than one without auxiliary poles, but not necessarily cheaper because the ratio of iron to copper is lower in an interpole machine and the greater cost of copper makes the cost of an interpole motor higher per pound of total material.

The multispeed motor is of the same general class as the adjustable speed, the difference being in the method of speed control. Multispeed motors can be operated at any one of several set speeds, each of which they maintain practically constant regardless of changes of load. This is best accomplished by some form of multiple-voltage supply system of which there are many in use.

Direct-current motors of all types excepting small fan motors are always started by some form of rheostat in the armature circuit which gradually cuts out resistance as the armature counter-electromotive force builds up, until the armature is directly across the line. These rheostats are usually equipped with a no-voltage release, which holds the starting arm at the running position against the pull of a spring (Fig. 5). If the supply current fails or the voltage falls to a very low value, the magnet is "killed" or weakened, releasing the arm, and the spring throws the arm to the "off" position. The release magnet is usually connected in series with the shunt field winding of the motor, but owing to the increasing use of motors with shunt field control, and the difficulty of designing a magnet for the wide current variations entailed, it is becoming customary to connect the release magnet across the line. This arrangement, however, has the disadvantage that it does not protect the motor in case of the accidental opening of the field-winding circuit. In addition to the no-voltage release many rheostats are equipped with an overload release, consisting of a magnet, the winding of which is connected in series with the motor armature. The magnet armature is so adjusted that when the current exceeds the safe value, it (the magnet armature) closes a short-circuit around the winding of the magnet which holds the rheostat arm, causing it to release the arm and thereby stop the motor. This device cannot be used when the retaining magnet receives the full line voltage.

It is always well to install fuses in addition to the overload release, and having the same rating. Owing to the time lag of the fuses the overload release will act first and save the fuses, but in case it should get out of order the fuses will protect the motor.

When adjustable speed is desired the starting rheostat is usually combined with the speed regulator. This may be done in several ways. The starting resistance may be made with sufficient capacity to carry the full-load current of the motor indefinitely and the retaining magnet arranged so that it will hold the rheostat arm on any step, in which case the motor may be left running on any one of the resistance steps and the starting rheostat serves also as a speed regulator. Such an arrangement is illustrated by Fig. 6. Another and better method is to add to the starting rheostat a field-regulating

resistance connected to contacts over which the rheostat arm travels after all the armature resistance is cut out. A combination of both methods is shown by Fig. 7. This makes it possible for all speeds below the natural speed of the motor to be obtained by means of the armature-circuit resistance and all speeds

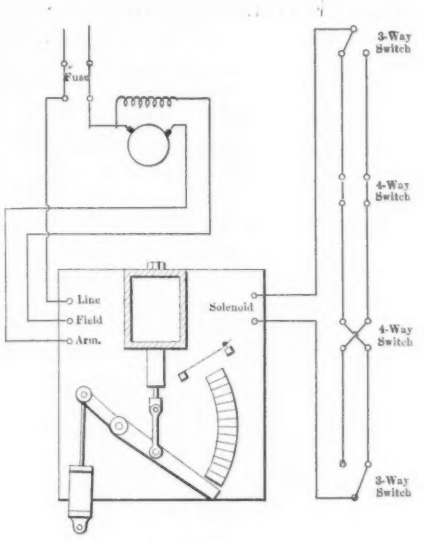


FIG. 8

above this by inserting more or less resistance in the circuit of the shunt-field winding.

In this connection it is well to note the differences existing between armature and field control. When the speed of a motor is controlled by means of a resistance in the armature circuit, the efficiency of the motor varies approximately as the speed; therefore, a motor running at half speed would show an efficiency of about 45 per cent. When field control is used the efficiency is nearly the same for all speeds. Another disadvantage of speed control by means of armature-circuit resistance is that constant speed cannot be obtained at any speed below the normal. For example, assume a motor with a certain load and sufficient resistance in circuit to cut down the voltage at the motor terminals one-half; the motor would run at half speed. Now suppose the load to be reduced to one-half the former value, resulting in a reduction of armature current to one-half the former value. The drop across the rheostat will be only one-half what it was before, and the motor must therefore run about 50 per cent. faster to generate the increased counter-electromotive force necessary to make up the difference. It is evident that a constant-speed motor changes to the varying-speed class when its speed is reduced by means of a resistance in the armature circuit. With shunt field control the speed variation due to load changes will be the same for any field strength, and it therefore follows that this control is the most satisfactory where practically constant speed is desired over the whole range of adjustment and also where the best efficiency is desired at all speeds.

There are other methods of adjusting the field strength besides the use of a variable resistance in the field-winding circuit, but most of them are based on the principle of varying the reluctance of the magnetic circuit; this is done either by adjusting the air-gap or by decreasing the cross-section of iron in the poles or yokes, but as such adjustments must be made at the motor itself the method is open to the objections that the motor must be within reach of the operator and that there is danger of the motor being started with a weakened field by a thoughtless operator, which is not possible with a properly designed regulating rheostat of which the starting and speed-controlling levers are interlocked.

In the multivoltage system the supply circuit comprises three or more wires between the pairs of which various voltages are maintained. Each of the principal running speeds is obtained with the motor connected directly to some pair of wires and therefore taking current at one of the line voltages; the intermediate speeds are obtained by either of the methods previously described.

A method of control by impressed voltage applicable only when two or more motors are connected to the same load, is the series-parallel method in universal use on railway cars. With this method each motor receives its proportion of the line voltage when the machines are connected in series, and resistance is used for the intermediate speeds.

When it is desired to start a motor from any one of several places remote from the starter, or where careless operators are unavoidably employed, an automatic starter may be used to advantage. This consists of a rheostat the operating lever of which is actuated by a solenoid

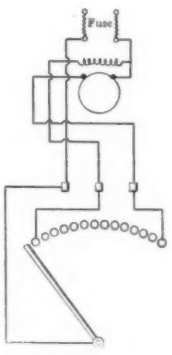


FIG. 9. CORRECT

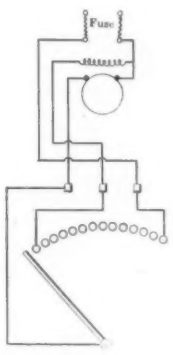


FIG. 10. INCORRECT

opposed by a dashpot. The solenoid takes only a very small current and may be controlled by ordinary snap switches located at the desired points, as indicated in Fig. 8. By suitable adjustment of the dashpot the motor may be made to accelerate to full speed in any desired number of seconds, regardless of the operator's wishes.

When connecting up a rheostat and motor care should be exercised not to connect the shunt-field winding across the brushes; it must be connected across the entire armature circuit, including the starting resistance, because when the motor is first cut in circuit at starting, almost all the drop is across the rheostat and therefore the field would not be excited and the motor would not exert the proper starting torque. This error can easily be made on most makes of starting rheostats simply by changing the two outside wires leading to the rheostat. Fig. 9 shows the correct and Fig. 10 the incorrect connections.

Dust Explosions in the Boiler Room

By C. M. Hansen

Upon a recent visit to a steam plant, the writer found the top of the boilers covered with from 4 to 6 inches of soot and coal dust. Upon asking why it was allowed to accumulate to that extent, the following reason was given by the engineer in charge: Two weeks previously they had started to clean it off with compressed air, when suddenly the dust, thereby put in suspension, ignited and exploded. Fortunately it did not hurt anybody seriously, neither did it injure the plant. It gave them all a bad scare, however, accompanied by a good practical lesson. Rather than run the risk of a recurrence of such an explosion, the engineer concluded to leave the dust where it was. The fact that a little sprinkling of water would materially have helped to keep the dust down evidently did not occur to him at the time.

Aside from the bad practice and poor principle evidenced, not taking into consideration the deteriorating effect on the boilers by allowing such an accumulation, in this case it might have resulted in an explosion as destructive to the plant, and entailing as great a financial loss, as if one of the boilers had blown up.

This is an entirely new phase in boiler practice. To my knowledge, no such explosion has ever been recorded to have taken place in a boiler room. It should, therefore, be of no little interest to any engineer who thinks it is not necessary to keep the boiler room as clean as the engine room.

Intake air for a compressor should not be drawn from a hot engine room or from any point where dust is abundant. The volume of air delivered by the compressor increases proportionately as the temperature of the intake is lowered and grit entering the compressor clogs the valves, cuts the cylinder and generally impairs the efficiency.

POWER AND THE ENGINEER

DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

During 1907 *we printed and circulated* 291,500 *copies of* POWER.

Our circulation for November, 1908, *was (weekly and monthly)* 153,000.

December 1	39,500
December 8	38,000
December 15	38,000

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

Contents

	PAGE
City Investing Building's Power Plant	983
Cost of Oil Fuel	988
A Troublesome Crank Pin and Its Cure	988
The Strength of Riveted Joints	990
Selection and Safety of Pipe Fittings	993
The Slipping Point of Rolled Boiler Tube Joints	994
An Interesting Condenser Action	995
Power Plant of St. Luke's Hospital	996
Tribulations of a Gas Power Pioneer	1001
Catechism of Electricity	1003
Practical Letters from Practical Men: Steaming Power of a Boiler Increased....Culm and Coal Dust for Fuel....High and Low Water Alarms....Closed Heater Strains....Filling Lubricators with Oil....Wants Pump Valve Information....Testing Boilers....A 500-or 250-Volt System for Motors....Weak Valve Caused Trouble....Bent Connecting Rods....Production of Power from Producer Gas Plants....Draining Steam Pipes....Motor Operation....Flywheel Accidents....Objectional Features of Some Gas Producer Plants....Combustion or Total Heat Formulas....Arrangement for Distributing Feed Water....Pumping Hot Water....A Motor Trouble	1004–1011
Gas Power Section of the A. S. M. E.	1012
The Mechanical Engineers	1014
Direct Current Motors	1015
Editorials	1018–1019

The Total Heat of Steam

At the recent meeting of the American Society of Mechanical Engineers two papers of more than ordinary interest to the industrial physicist were presented. A. R. Dodge, of Schenectady, N. Y., whose work on the determination of the specific heat of superheated steam is well known, presented to the society a variation of the throttling-calorimeter method by which it is possible to determine the ratios of the specific heats at various pressures and superheats, without recourse to the steam tables, where the accepted values of total heat are too unreliable for accurate work. When proper and accurate initial values of the specific heat are obtained by direct experiment, this method may be used for all other values within the range of the experimental data.

The unreliability of the steam tables has been noticed by many workers in this field, notably since the attempt has been made to use the throttling calorimeter for specific-heat determinations. Dr. Harvey N. Davis, in connection with Prof. L. S. Marks, both of Harvard University, has been working at this problem for some time, and Doctor Davis' paper is an account of their work in deducing the total heat of steam from the throttling experiments of Grindley, Griessman and Peake, and the development of a new empirical formula for the total heat to replace Regnault's classic

$$H = 1091.7 + 0.305\ (t - 32).$$

This formula gives results probably eighteen heat units too high at 32 degrees Fahrenheit, six heat units too low at 275 degrees Fahrenheit and too high again at 380 degrees, the error increasing rapidly at higher temperatures. The new formula given by Doctor Davis is

$$H = 1150.3 + 0.3745\ (t - 212) - 0.00055\ (t - 212)^2,$$

which is probably accurate to one-tenth of one per cent. between 212 and 400 degrees Fahrenheit.

As the error in the present tables in the middle range is not more than one-half of one per cent., the changes will not affect the work of the engineer to any extent, but the new values will be used for experimental work on superheat and many of the discrepancies hitherto noticed may disappear. It is of interest to note that the heat unit used by Doctor Davis is one-one hundred and eightieth of the heat required to raise one pound of water from 32 degrees Fahrenheit to 212 degrees Fahrenheit, instead of the heat required to raise one pound of water from 39 to 40 degrees Fahrenheit, the difference being about one-twentieth of one per cent. The steam tables are being recalculated on this basis and will shortly be published under the joint authorship of Doctor Davis and Professor Marks.

The Merit System

An incentive to better work and strict attention to duty is the knowledge that something is to be gained other than the regulation weekly stipend. This applies to any line of employment, but in dealing with power-plant forces the merit system would necessarily deal with plants of large size, where a number of men are employed. In the smaller plants, it would not work out as satisfactorily, due to the limited available material to work with.

There is no reason why the merit system cannot be applied from the moment a new man is employed; neither is it necessary that he should have been employed in any particular capacity in the steam plant before holding his present position. For instance, the coal passer may have faculties which, if properly developed, would fit him to assume charge in the engine room. As an incentive for advancement, the merit system would be a stimulant and could be applied to the manner in which he did his work, his willingness to help about the steam plant, punctuality, sobriety and general good character.

When a stipulated number of merit points have been attained, the coal passer could be given an opportunity to stand an examination before the chief engineer relating to his duty as a fireman and his fitness to assume such duties. If he shows that he has improved his opportunity to learn how to discharge such duties, he should be placed in line for advancement. The same idea may be applied to the fireman. His method of firing should be noted and, if deficient, proper instruction given. Hardly anywhere about the steam plant can more economy be obtained by attention to duty than in the fire room. But it is a wrong idea to go on the supposition that because a man is a good fireman he should be kept in front of the boilers. The probabilities are that, with the proper encouragement and training, he will develop into a better engineer than fireman. This also applies to the water tender, pump man, oiler and other assistants.

If a man proves efficient and shows that he has the characteristics which qualify him to become a successful engineer, he should be given the opportunity. The chief engineer, by following out this plan, would have a most efficient organization; his subordinates would be of such caliber that they could be depended upon at all times, and he would know just what reserves to fall back upon, should a change be made in the working force of any department, as his record would show the capabilities of each man.

At stated periods the chief could examine those desiring promotion, and if the standing of any one man was low he would have no excuse to find fault because another was promoted over his head. By adopting this method of promotion, the

men would always have something to work for, at the same time occupying as good a position as if employed by a firm where nothing was held out in the line of advancement.

Consolidation of New York Headquarters

Engineers of Brooklyn have been greatly aroused by the recent removal of the examining office to police headquarters in Manhattan, and apparently feel that they will be put to unnecessary inconvenience in securing licenses. The Manhattan office is at a greater distance from their work or their homes, and on account of the greater number to be examined, they have been subjected to longer delays than they ever experienced in Brooklyn. This is the engineers' side of the story and is perhaps justifiable to an extent; but Commissioner Bingham has a different story to tell and one which makes these minor objections look unreasonable.

In the first place, it is stated that there are only 3000 licensed engineers and firemen in Brooklyn, and 4000 boilers. To maintain an office the year around and retain the services of one sergeant, two patrolmen and two civilian boiler inspectors, entails an expense out of proportion to the work to be done, so that the consolidation is simply a matter of good business policy and allows four extra men and one sergeant to report to headquarters for duty. These same men can handle the Brooklyn work and much more besides, and in this way a considerable saving in money and men is effected. In addition the clerical work is cut in two. Every sergeant in Brooklyn must in all events make out a report for headquarters in Manhattan and another for Brooklyn. With the present arrangement only one report is required, and its arrival at headquarters is facilitated. For instance, the Borough of Queens formerly sent her reports to the Brooklyn office, and from here they were forwarded to headquarters. With no good crosstown connection between Queens and Brooklyn, the reports were sent by way of Manhattan and were returned over a part of the same route to headquarters. By sending the reports directly, they are now received six hours in advance. The incident just noted may not have a direct bearing on the subject, but tends to show the efforts of an honest executive giving a good business administration.

As to convenience in reaching headquarters, it may be stated that the present office is within a distance of three hundred feet from Bleecker street station of the subway, and when once in the tunnel it is surely not much of a hardship to remain for a few minutes longer. In the near future police headquarters will be located in close proximity to the Williamsburg bridge over the East river, and will be in direct communication with a subway station. The location is as nearly central as could be had, and in most cases would be just as convenient to reach, if not more so, as an office in Brooklyn. Not only this, but the certificates are now mailed to the engineer, doing away with the second trip which was formerly required.

It is, of course, hard for Brooklyn to give up her offices, and much harder for Brooklyn's politicians, and it would appear that a great deal of the "noise" originates from this source, rather than from the average good citizen and engineer. It is not Commissioner Bingham's intention to inconvenience Brooklynites in any way, and if the engineers and firemen are unreasonably delayed when appearing for examination, the trouble will undoubtedly be remedied by the appointment of a larger force to handle this particular branch of the service.

To have the examining board under the supervision of the police department would appear to be a much more reasonable cause for complaint. What do patrolmen, their officers and the average commissioner know about boilers, engines or engineers' licenses? It is rather the duty of a bureau of inspection under the Public Works Department, and any efforts on the part of New York engineers to make the change would be gladly seconded by the police department.

The Lap Seam Boiler Again

What might have proved to be a disastrous explosion of another lap-seam boiler was prevented by the prompt shutting down of the factory of the Charles E. Harwood Counter Company, Lynn, Mass., on Saturday forenoon, November 28. While passing from the boiler room to the engine room the engineer noticed a small amount of steam coming out through the brickwork covering the top of the boiler. Knowing that there were no legitimate holes for the escape of steam under the brickwork, he decided that something not expected in regular practice was going on and promptly shut down. Removal of the brickwork over the leak revealed a crack, eighteen inches long, in the outer sheet along the row of rivets.

This boiler was of the type that was in almost universal use eighteen or twenty years ago, and is still largely made in many States, but the further installation of which has been forbidden in Massachusetts. It is like those which failed in Lynn and in the Grover shops at Brockton. It is of a type that renders satisfactory inspection impossible at the very point where the boiler is known to be weakest. Only the unmaking of the seam will allow an effective inspection of the boiler.

It has often been stated that this form of boiler construction is mechanically wrong and morally criminal, and it only remains for the legislatures of the various States to fix a date upon which the last boiler of this type shall be forbidden to be used for steam generating.

There are thousands of these boilers in use, every one of which will surely fail some time, if continued in service. It is not because the joint is weaker than it should be in the beginning that it is dangerous, but because of the repeated bending which occurs, at every change of pressure, which finally cracks the sheet at the place where the most severe flexure takes place — along the row of rivet holes. Cheapness of construction has been supposed to be the only reason for the making of boilers with lap seams, but when it is found that a boiler of equal strength with butt and strap joints costs less money this flimsy excuse fails.

Receiver Pressure

An engineer asks: "What is the proper receiver pressure to be carried that the load may be equally divided between the cylinders?" Of course, only indicator diagrams will show when the load is evenly divided, and the vacuum pressure that obtains when the load is divided is the proper receiver pressure to carry with that particular load, if balancing the load is considered the chief object to be attained.

Primarily engines are installed for the purpose of carrying a certain load. Whether the load be carried with the least possible expenditure of steam is really a secondary consideration. It is, however, desirable that the engine shall be operated as economically in the use of steam as its design, the load carried and the steam pressure furnished will allow. Now, this condition in a compound-condensing engine may be fulfilled when the load is far from being balanced. With an engine having a fly-ball governor the plane in which the balls revolve determines the point of cutoff in one or both cylinders, but always in the high-pressure cylinder. When the cutoff is short, the balls revolve in a higher plane than when the cutoff is longer, and less steam is used with the short cutoff than with the longer one.

In seeking to operate an engine with the least possible quantity of steam for a given load, the end sought will be found when the governor balls revolve in the highest possible plane giving the shortest possible cutoff. Receiver pressure has a great deal more to do with the point of cutoff and consequently with the amount of steam per horsepower-hour than is generally supposed.

In determining the proper receiver pressure for a compound engine, that pressure should be chosen which will cause the governor balls to revolve in the highest possible plane, and this pressure should be carried whether or not it results in equalizing the load between the cylinders if economy of steam is desired.

Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

Caskey Valves

The Caskey Valve Company, 422 Arcade building, Philadelphia, is placing on the market a valve of unusual construction, so arranged that it is said to become more effective as the pressure is increased.

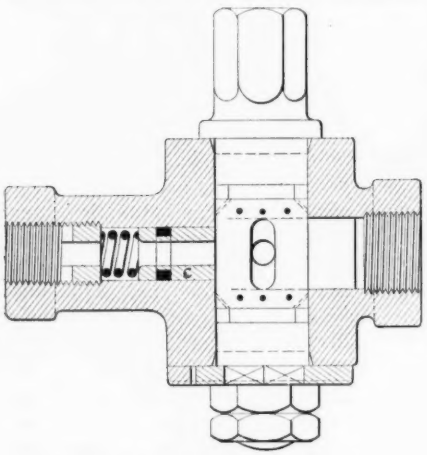


FIG. 1. A NEW CASKEY VALVE

this valve. The bushing is recessed and filled with a washer with small portholes at the back, so that the pressure gets back of the washer and forces it out. The same principle is involved in the plug, which is a straight-through plug, without taper, thus making an equally balanced valve.

In Fig. 2 is shown a single-ram-operating valve. This valve is designed for single-ram pressure, where quick and accurate control is required giving a maximum efficiency in maintenance.

In Fig. 3 is shown a blowoff valve, consisting of the same parts as shown in Fig. 1. This is said to be the only blowoff valve ever designed and constructed where the valve has absolutely no pockets or recesses and is straight-through. It is designed to carry up to 500 pounds pressure. This valve consists of a body *A*, a straight plug *B* and a bushing *C*.

Another type of valve having no pockets of any sort where scale or grit can lodge is shown in Fig. 4. It is straight-through, without any choke or taper, positive in its action and easy to operate. This valve is manufactured in sizes from 1 inch to 3 inches.

The company has also placed on the market a valve designed for long-stroke presses where the maximum pressure is not used throughout the stroke. They are also made automatically to throw on the heavy pressure at any part of the stroke.

The company also makes a main stop valve to be placed on a line between boilers to permit the cutting off of either boiler. In designing this valve two sealing plugs are used, so that whichever way the pressure might be exerting its force the valve becomes operative and tight.

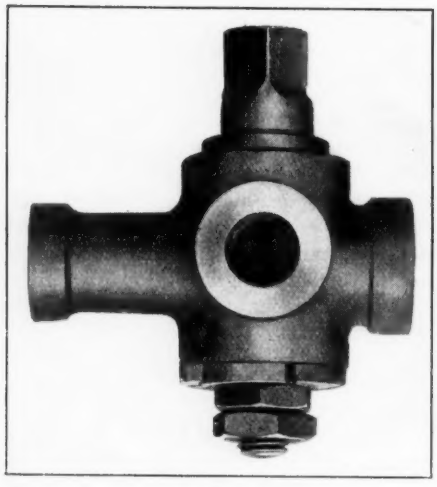


FIG. 2. SINGLE-RAM VALVE

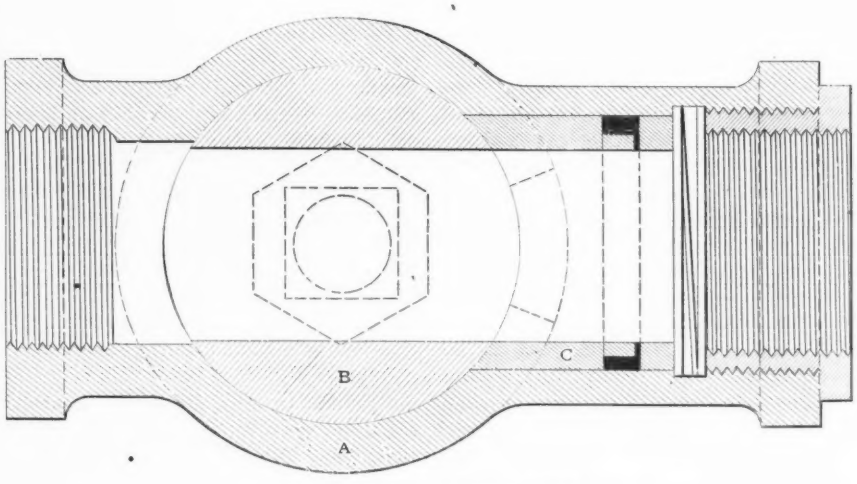


FIG. 3. CASKEY BLOWOFF VALVE

It is manufactured in brass, steel and iron, and used under pressures of from 250 to 10,000 pounds per square inch. The smallest size made is ¼-inch and the largest 5-inch.

In the construction of this valve the taper plug, change of flow with a reduction of area and all pockets have been done away with. The valve is made, as shown in Fig. 1, of the body, a straight plug and a bushing ground to fit the plug. To insure contact, a spring is provided as shown. There is no exposed seat in

The Kelly Improved Fire Door

The accompanying illustrations show the construction and application of the Kelly improved fire door, manufactured by the Kelly Foundry and Machine Company, Goshen, Ind.

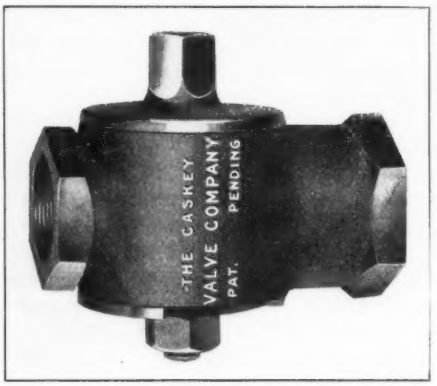


FIG. 4. ANOTHER CASKEY VALVE WITHOUT POCKETS

In operation, the air passes through the perforations in the door and, striking the deflecting plate, is heated, and then passes under the deflecting plate into the furnace. It is claimed that the current of heated air in passing into the furnace, through the opening causes a whirling motion of air in the front of the furnace, thus drawing the gases and smoke as they rise from the fuel toward

the front of the furnace, where they are held by the continued entry of air, the gases becoming ignited before they pass over the bridgewall. This is illustrated in Fig. 1.

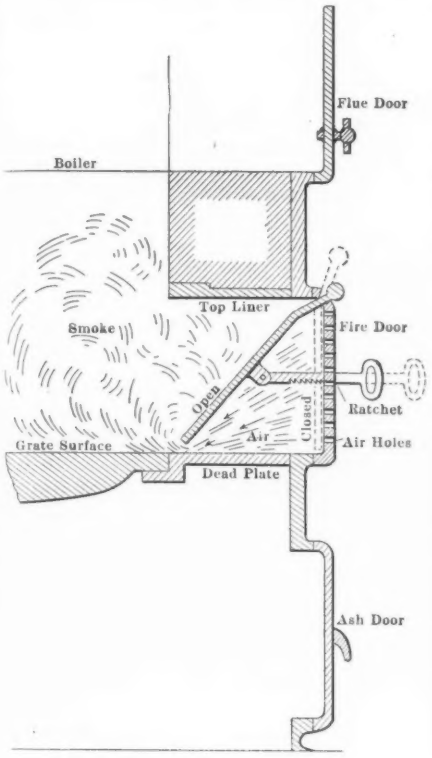


FIG. 1

Figs. 2 and 3 show a front view of the door in two positions.

It is claimed that with this door the fuel can be burned with greater efficiency, because of the retention of the gases and smoke in the furnace until full ignition has taken place, and the formation of clinkers is said to be almost entirely avoided and the output of ash greatly reduced.

Bristol's Electric Time Recorder

A new Bristol electric time recorder has been designed to record automatically the occurrence and duration of various operations, such as the starting and stopping of machines, the opening and closing of valves, the duration of runs, etc. With this instrument it is possible to record several different operations on the same chart, and the recorder may be located at a distance from the points at which such operations occur.

One of these recorders, arranged to record operations at six different points, is shown in Fig. 1. Each one of the six pens shown makes an independent record, continuously and automatically, and in this way six different operations may be recorded on the same chart. Each pen arm is actuated by an independent electromagnet and battery circuit, so arranged that closing the circuit causes the pen to move a certain distance on the chart.

FIG. 1. SIX-PEN BRISTOL TIME RECORDER

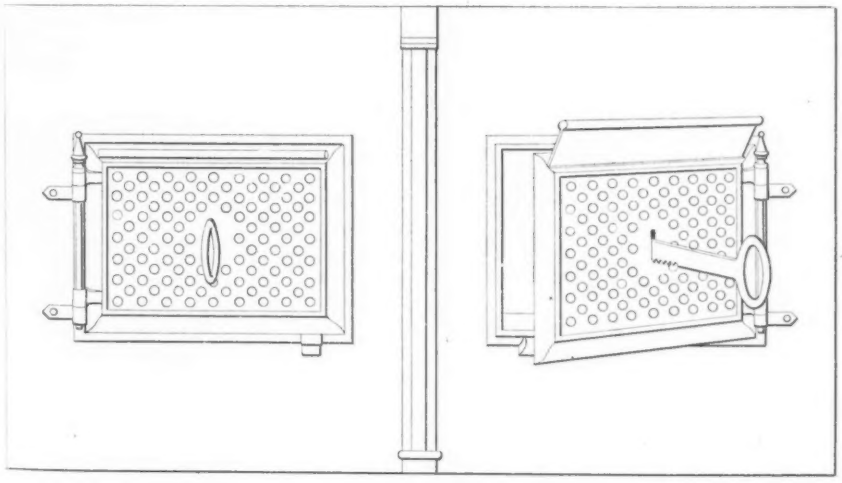


FIG. 2

FIG. 3

Fig. 2 is a reproduction of a record chart showing complete 24-hour records of the operation of two machines. This record shows the time and duration of each stop.

FIG. 2. TWO-MACHINE CHART

Binding posts are provided at the base of the recorder, to which pairs of lead wires are attached. These wires may be of almost any desired length, it only being necessary to have the object whose motion is to be recorded open or close the circuit whenever the motion occurs.

The Bristol Company, of Waterbury, Conn., is the manufacturer of these instruments.

Westinghouse Electric and Manufacturing Company Directorate

At the meeting of the Westinghouse Electric and Manufacturing Company, held at East Pittsburg, November 30, final action was taken by the stockholders prior to the termination of the receivership. While the attendance of individual stockholders was no larger than at the previous week's meetings, the proxy representation was much larger. E. M. Herr, vice-president of the company, acted as chairman and Charles A. Terry as secretary.

The object of the meeting was to pass resolutions amending the by-laws so as to allow of the election of sixteen directors, to classify the directors into one-, two-, three- and four-year terms, and to provide for the election of a proxy committee. These resolutions being unanimously passed, the following board of directors was submitted to the stockholders and was elected as follows for their respective terms:

For the class whose term expires on the third Wednesday of July, 1909, Richard Delafield, E. C. Converse, Anthony N. Brady and J. D. Callery.

For the class whose term expires on the third Wednesday of July, 1910, A. G. Becker, George M. Verity, William McConway and Charles A. Moore.

For the class whose term expires on the third Wednesday of July, 1911, Charles F. Brooker, James S. Kuhn, Edward F. Atkins and E. M. Herr.

For the class whose term expires on the third Wednesday of July, 1912, George Westinghouse, Neal Rantoul, Joseph W. Marsh and Albert H. Wiggin.

The last action of the meeting was the election of a proxy committee which resulted as follows: James N. Jarvie, Jacob H. Schiff, Charles Francis Adams, Robert S. Smith and F. W. Roebling.

Marine Engineers' Benevolent Association

"Standing room only" was the call at the entertainment and ball of the Marine Engineers' Benevolent Association, No. 33, on Wednesday evening, December 2, at Lexington opera house, New York. Irrespective of the large attendance, the committee succeeded in making everybody happy. Many of the prominent engineers and representatives of supply houses in the vicinity were present. The hall was decorated in a tasteful manner. After enjoying a vaudeville program of unusual excellence, the guests indulged in dancing. In every way the occasion was a pronounced success. The committee of arrangements were William J. Du Bois, Daniel Murphy and James J. Waters. Herbert Self was the floor director and Frantzen's orchestra furnished the music.

The entertainment and ball of the Eccentric Association of Engineers No. 1, of Greater New York, was held on Saturday evening, December 5, at Amsterdam opera house. The occasion proved a decided success, and in the matter of numbers was the largest social event yet held by this organization. An enjoyable vaudeville entertainment was followed by a long dancing program. The several committees were constantly on the alert to assure everyone a good time. Thomas McVeigh was the floor manager, assisted by John Quain. During the past year this association has more than tripled in membership, and is at present in a most prosperous condition.

Business Items

H. B. Underwood & Co., 1021 Hamilton street, Philadelphia, is sending out a large wall calender for 1909.

The Wisconsin Engine Company, of Corliss, Wis., is giving away upon application a handsome nickel-plated center level, which is well worth sending for.

The Chehalis Furniture Manufacturing Company, Chehalis, Wash., has placed an order with the Minneapolis Steel and Machinery Company for an 18x36 heavy-duty Twin City Corliss engine and feed-water heater.

The Parker Boiler Company, Philadelphia, Penn., is erecting two 150-horsepower and one 262-horsepower boilers in Chicago, Ill.; also, one 300-horsepower boiler for Thomas Devlin Manufacturing Company, Burlington, N. J.

William Wallace Christie, of Paterson, N. J., has a number of little eight-page folders upon Horsepower, Belting, Weights and Measures, Heat and other Useful Information, of which he will send a full set to anyone sending his address with 4 cents in postage stamps.

Geo. H. Thacher & Co., of Albany, N. Y., has received an order for installing the Coe combustion and draft system in the eight boilers of the New York State Reformatory, at Elmira, N. Y. The work is to be rapidly pushed so as to be completed about the middle of December.

The Cuban demand for "non-fluid" oils has grown to such an extent that the manufacturer, the New York and New Jersey Lubricant Company, has decided to place a stock of its various grades with agents in every town of any size on the island. W. F. Kimball, vice-president of the company, has just gone to Cuba to facilitate the arrangements. James B. Clow & Co., Obispo 36, Havana, are to act as distributors and W. N. Anderson, who is well known among Cuban buyers, will give his personal attention to all inquiries for the company's products.

The Paragon Refining Company, Gibsonburg, Ohio, installed a Buckeye boiler skimmer in its boiler at its Woodville plant. The superintendent writes in regard to it as follows: "We believe that we have given it a fair test, and so far are well pleased with results. The water at this point being impregnated with salt to a large degree, we were somewhat skeptic of the device being a purgate of this particular enemy, but find that it acts with as much efficiency with this as it does with mud and kindred substances. Should its future be as meritorious as its past, we will have no cause for complaint; we therefore have no hesitancy at this writing in giving it our approval." This skimmer is made by the Buckeye Boiler Skimmer Company, South End, Toledo, Ohio.

We have received a copy of the 1909 edition of the Westinghouse diary issued by the Westinghouse Company's publishing department, Pittsburg, Penn. This is the fifth edition and contains more information of interest to engineers and users of power apparatus than any of the former editions. Especial attention is called to the information published with reference to the following subjects: High-pressure steam turbine, Leblanc condenser, low-pressure steam turbine, mechanical stoker, mercury vapor lamps, meter testing, storage battery, single-phase railway systems, tungsten lamps, turbo pumps and blowers, Westinghouse-Nernst lamps. There is also a complete diary for every day in the year with space for memoranda, maps of the United States and possessions and other interesting information, including yearly calendars for 1909 and 1910. The book is vest-pocket size, bound in rough leather.

"The Wheeler-Edwards Air Pump" is the subject of an elaborate 32-page treatise published by the Wheeler Condenser and Engineering Company, Carteret, N. J. The peculiar action of the Wheeler-Edwards pump in handling both air and water is explained and it is shown how the absence of foot and bucket valves and an exceedingly small clearance, result in the attainment of a high vacuum otherwise to be had only by means of separate dry-vacuum pumps, hot-well pumps and air coolers. Various types of the Wheeler-Edwards pump are shown, also a number of large steam-turbine installations in which these pumps are used. The latter half of the book is made up of discussions of the principles of air pumps, tables of mixed vapors, a complete and original table of saturated water vapor from 60 to 180 deg. F., etc. The final section gives practical instructions for the handling of pumps of this character. The booklet should be valuable to anyone interested in vacuum machinery.

New Equipment

The city of Elgin, Texas, is considering the construction of water-works.

The Danville (Ind.) Heat, Light and Power Company will enlarge its plant.

The city of Haskell, Texas, will vote on issuance of $23,000 bonds for water-works

The ice plant of the Crystal Hygeia Ice Company, New York, will be enlarged.

The Goliad (Texas) Motor and Light Company will construct a lighting plant.

The Cuero (Texas) Light and Power Company is rebuilding its plant recently burned.

The city of Anadarko, Okla., will construct a hydro-electric plant at a cost of $80,000.

The Huntington (W. Va.) Pasteurized Milk Company will install cold-storage equipment.

The Montreal (Que.) Light, Heat and Power Company will erect an additional steam plant.

The city of Jefferson, Texas, has voted to issue $10,000 bonds for extending water-works.

The citizens of Marietta, Ga., voted to issue $80,000 bonds for construction of water-works.

A new power house will be erected for the Union Railway Company, Bronx, New York.

Plans are being drawn for a power house for the sacred Heart Hospital, Spokane, Wash.

The city of Ryan, Okla., will vote on issuance of bonds for construction of electric light plant.

Samuel Rosenberg, Baltimore, Md., has awarded contract for $10,000 addition to tannery.

The Tuckerton Manufacturing Company, Tuckerton, N. J., plans to build an electric lighting plant.

The Berryville (Va.) Ice Company has been organized and will erect an ice and cold-storage plant.

The Ft. Wayne and Wabash Valley Traction Company will remodel its power house at Lafayette, Ind.

It is reported that the Griswold (Iowa) Milling and Light Company expects to nstall a new generator.

The municipal electric light and water plant at Waverly, Iowa, recently destroyed by fire, is to be rebuilt.

The citizens of Winlock, Wash., voted to issue $15,000 bonds for water works. C. E. Lemard, city clerk.

Bids will be received about February 1 for construction of water works at Osceola, Kan. Cost, about $25,000.

The village trustees, Bergen, Neb., are said to be considering the construction of a municipal lighting plant.

Plans are being considered by the McPherson (Kan.) Water and Electric Company for increasing its output.

The People's Light Company, Davenport, Iowa, it is said, is contemplating improvements to cost about $200,000.

The Barium Orphans' Home, Barium Springs, N. C., will construct an electric-light plant and sewerage system.

Bids will be received about February 1 for construction of water works at Osceola, Ark. S. L. Gladish, mayor.

The city of Coaldale, Penn., is said to have voted to issue $35,000 for improvements and a municipal light plant.

The Windham Manufacturing Company, Willimantic, Conn., has commenced construction on its new power plant.

Bids will be received for the construction of water works at Colfax, Ill., to cost about $12,000 J. S. Barnes, village clerk

Remember One Thing!

The American Steam Gauge & Valve Mfg. Co. manufactures only the highest grade of engineering specialties. ∴ ∴

WE do not manufacture cheap goods and claim distinction from that class of manufacturers who sell goods strictly on price.

If you are looking for cheap goods, it will be useless to apply to us, but if you are looking for the kind that last and save dollars, we have them.

We are after all the business we can get, but we do not want the business that is to be obtained by the manufacture of the cheapest possible article and corresponding price.

We are after the orders of the discriminating buyers who demand the goods that give the right kind of service and wear the longest.

The policy of this company is first to manufacture the best article which can be produced and then to sell it at the most reasonable price at which it can be sold and make a living profit.

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American Steam Gauge & Valve Mfg. Company

208-220 Camden Street, Boston, Mass.

New York, 26 Cortlandt St. Atlanta, 835 Equitable Bldg. Chicago, 7-9 So. Jefferson St.

Pittsburg
Montreal, 444 St. James Street
San Francisco, Monadnock Bldg.
Los Angeles, 213 So. Los Angeles St.

When ordering gauges, valves, indicators and kindred appliances for governing, indicating, measuring, recording and controlling steam, air, gas, oil, ammonia and all other pressures, be sure to specify those manufactured by us.
Your interests can be best served by the protection they afford.

Help Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

SALESMEN WANTED to sell a high-grade steam specialty. Must be competent. Address P. O. Box 467, Altoona, Pa.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

WANTED—By prominent engineering house on the North Pacific coast, a practical mechanical draftsman. One acquainted with power plant design preferred. Splendid opening for one who is in earnest. Address, giving full particulars as to qualifications, salary wanted, etc. Box 65, POWER.

AGENTS to sell one of the best known and widely advertised shaking grates on the market. Exclusive territory granted to anyone who can make good. Liberal commission. Perfection Grate Co., Box 1081, Springfield, Mass.

Situations Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

CHIEF ENGINEER having 20 years' experience with modern engines, boilers and a.c. and d.c. generators, desires position. Can give references and good economy. Box 61, POWER.

I WOULD LIKE TO CORRESPOND with parties desiring a reliable engineer for a manufactory or electric plant. Now employed. "H. L.," POWER.

POSITION WANTED as chief engineer or electrician of large plant. Expert electrician, practical machinist and steam engineer. Can operate at lowest cost, wind armatures, (all kinds), install machinery, make steam and electrical tests, use indicators. Experience on both a.c. and d.c. systems, high tension. Thirty-two years old, reliable, sober and industrious; best references; technical education. At present master mechanic of industrial plant. Box 72, POWER.

POSITION WANTED as stationary engineer. Am blacksmith and machinist. Route No. 3, Box 39, Fairfax, Minn.

YOUNG MAN, at present employed, desires change as purchasing agent to large corporation. Wide experience, United States and Canada, in all classes of machinery and supplies. Exceptional references. Salary $2,000. Box 71, POWER.

YOUNG MAN now holding position as chief engineer, familiar with steam turbines, all branches of electrical work, office work, wants position as superintendent. With present employer four years. Best references. Box 70, POWER.

Miscellaneous

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PATENTS secured promptly in the United States and foreign countries. Pamphlet of instructions sent free upon request. C. L. Parker, Ex-examiner, U. S. Patent Office, McGill Bldg., Washington, D. C.

HERE'S A LIVE ONE—I can put the right people in negotiation with an enterprising manufacturing town of 30,000 people, who want a factory producing boilers for traction engines, and will use the output of a good large concern. Free site, good railroad facilities, no commissions, no graft,—strictly a business proposition. Great opportunity for those who may wish to establish such a manufacturing business. Address "F. F. B.," POWER.

For Sale

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—30 H.P. suction gas producer. Now in daily operation; in use eight months. Termaat & Monahan Co., Oshkosh, Wis.

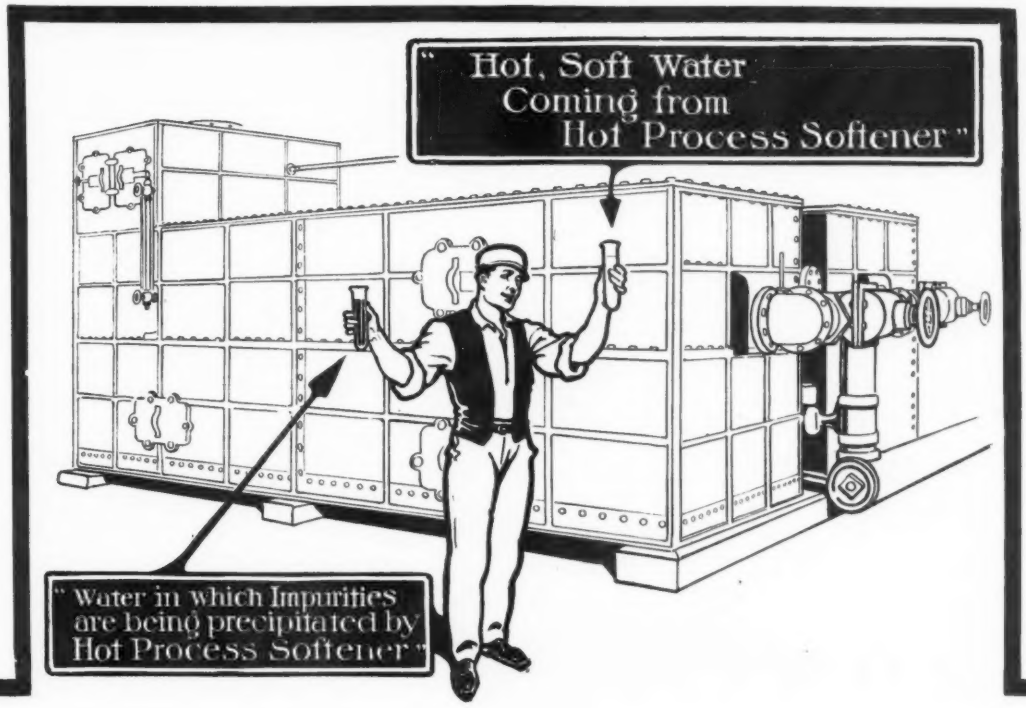
FOR SALE—Direct-connected engine and generator. 100 kw.; direct current; good as new. Address Monarch Machine Works, Altoona, Pa.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—20"x42" improved Greene engine. Wheel 32"x14'. Used seven years. Also 24"x48" improved Greene engine. Wheel 42"x16'. Used eight years. Both engines in first class shape. Can be seen running. The Capewell Horse Nail Co., Hartford, Conn.

Alphabetical Index to Advertisers

	PAGE
Alberger Co., A. H.	109
Alberger Condenser Co.	99
Allan & Son, A.	108
American Boiler Economy Co.	101
American Diesel Engine Co.	108
American District Steam Co.	91
American Engine Co.	110
American Goetze-Gasket and Packing Co.	72
American Injector Co.	79
American School of Correspondence	63
American Steam Gauge and Valve Mfg. Co.	51
Anderson Co., V. D.	93
Andrews Mfg. Co., Thomas	1
Armstrong Mfg. Co.	73
Ashton Valve Co.	77
Babcock & Wilcox Co.	103
Ball-Cooley Engineering Co.	109
Ball & Wood Co.	108
Ball Engine Co.	109
Baragwanath & Son, Wm.	100
Barnes Co., W. F. & Jno.	100
Bates Machine Co.	97–111
Beggs & Co., Jas.	92
Berry Engineering Co.	102
Bignall & Keeler Mfg. Co.	78
Binghamton Boiler Compound Co	87
Bird-Archer Co.	87
Bowers Rubber Works	72
Bristol Co.	116
Broomel, Schmidt & Steacy Co.	107
Buckeye Boiler Skimmer Co.	87
Buckeye Engine Co.	108
Burt Mfg. Co.	10
Cancos Mfg. Co.	73
Carey Co., Philip	92
Carpenter & Co., Walter D.	82
Chaplin-Fulton Mfg. Co.	102
Chesterton Co., A. W.	73
Clark Bros. Co.	113
Climax Smoke Preventer Co.	90
Cling-Surface Co.	59
Continental Natural Gas Alcohol Co.	108
Cook's Sons, Adam	84
Cooper Co., C. & G.	112
Coralline Drug & Chemical Co.	9
C-O-Two Furnace Co.	91
Crocker-Wheeler Co.	106
Crosby Steam Gage & Valve Co.	57
Curtis & Curtis Co.	79
Davis Regulator Co., G. M.	102
Dean Bros. Steam Pump Works	100
Deane Steam Pump Co.	100
Dearborn Drug & Chemical Works	5
De Laval Steam Turbine Co.	111
De La Vergne Machine Co.	112
Deming Co.	99
d'Este Co., Julian	102
Detroit Leather Specialty Co.	57
Detroit Lubricator Co.	85
Diamond Rubber Co.	68
Direct Separator Co.	91
Dixon Crucible Co., Jos.	82
Du Bois Iron Works	107
Eastwood Wire Mfg. Co.	73
Eclipse Feed Water Heater & Purifier Co.	96
Edge Moor Iron Co.	103
Engberg's Electric & Mechanical Works	106
Epping-Carpenter Co.	100
Erie City Iron Works	95
Erie Mfg. and Supply Co.	112
Eureka Packing Co.	69
Fairbanks Co.	106
Fisher Governor Co.	102
Fitchburg Steam Engine Co.	109
Foos Gas Engine Co.	107
Fort Wayne Electric Works	105
Ft. Wayne Foundry & Mach. Co.	108
Gardner Governor and Separator Co.	102
Garlock Packing Co.	7
General Electric Co.	111
Gibson Iron Works Co.	89
Goulds Mfg. Co.	100
Green Engineering Co.	91
Green Fuel Economizer Co.	95
Greene, Tweed & Co.	61–116
Griffith & Wedge Co.	109
Griscom-Spencer Co.	97
Hammel Oil Burner Co.	87
Harris Oil Co., A. W.	83
Harrisburg Pipe and Pipe Bending Co.	97
Harrison Safety Boiler Works	53
Hawk Eye Compound Co.	87
Heine Safety Boiler Co.	104
Henry Steam Flue Cleaner Co.	82
Hershey Machine and Fdry. Co.	93
Hill Publishing Co.	64, 67, 98
Hoffman, Geo. W.	108
Homestead Valve Mfg. Co.	76
Hoppes Mfg. Co.	91
Houchin-Aiken Co.	57
Houghton & Co., E. F.	94
Huyette Co., Paul B.	78
Illinois Malleable Iron Co.	61
International Correspondence Schools	101
Jefferson Union Co.	76
Jeffrey Mfg. Co.	89
Jenkins Bros.	74
Johns-Manville Co., H. W.	61
Johnson Co., Henry	71
Keeler Co., E.	103
Kewanee Boiler Co.	105
Keystone Lubricating Co.	3–115
Kitts Mfg. Co.	94
Lagonda Mfg. Co.	80
Lammert & Mann	110
Leavitt Machine Co.	78
Liberty Mfg. Co.	81
Lippincott Steam Specialty & Supply Co.	57
Loew Mfg. Co.	92
Lunkenheimer Co.	65
McClave-Brooks Co.	88
McCrea & Co., James	79
McGowan Co., Jno. H.	100
McLeod & Henry Co.	89
Martin Grate Co.	90
Mason Regulator Co.	76
Mayville Specialty Mfg. Co.	90
Mercer Rubber Co.	72
Minneapolis Steel and Machinery Co.	114
Morehead Mfg. Co.	93
Morrin Climax Boiler Co.	103
Mound Tool and Scraper Co.	61
Murphy Iron Works	91
Myers & Bro., F. E.	100
National India Rubber Co.	71
National Pipe Bending Co.	95
National Tube Co.	78
Neemes Bros.	89
Nelson Valve Co.	75
New York Belting and Packing Co., Ltd.	70
New York & New Jersey Lubricant Co.	83
Northern Electrical Mfg. Co.	109
Ohio Blower Co.	93
Ohio Brass Co.	77
Ohio Injector Co.	79
Oil Well Supply Co.	104
Oster Mfg. Co.	57
Parker Boiler Co.	105
Patterson & Co., Frank L.	97
Peerless Rubber Mfg. Co.	67
Penberthy Injector Co.	8
Pennsylvania Flexible Metallic Tubing Co.	63
Philadelphia Lubricator and Mfg. Co.	83
Phoenix Iron Works Co.	109
Pierce Co., Wm. B.	2
Pittsburgh Gage & Supply Co.	84
Pittsburgh Valve and Fittings Co.	76
Pittsburgh Valve, Foundry and Construction Co.	77
Platt & Co., John	93
Power Specialty Co.	105
Presbrey Fire Brick Wks.	89
Providence Engr. Works	109
Quaker City Rubber Co.	4
Randle Machinery Co.	111
Reeves Pulley Co.	109
Reliance Gauge Column Co.	94
Restein Co., Clement	71
Rhoads & Sons, J. E.	86
Ridgway Dynamo and Engine Co.	113
Riverside Engine Co.	107
Robb-Mumford Boiler Co.	104
Robertson & Sons, Jas. L.	69
Robins New Conveyor Co.	85
Rust Boiler Co.	103
St. John, G. C.	79
Saginaw Mfg. Co.	86
Salamander Grate Bar Co.	90
Sawyer Belting Co.	86
Schaeffer & Budenberg Mfg. Co.	87
Schieren Co., Chas. A.	86
Schuchardt & Schutte	99
Schutte & Koerting Co.	61
Scully Steel & Iron Co.	76
Shepherd Engineering Co.	109
Shultz Belting Co.	85
Sirocco Engineering Co.	91
Skinner Engine Co.	108
Smooth-On Mfg. Co.	6
Southwark Foundry and Machine Co.	109
Standard Gauge Mfg. Co.	57
Starrett Co., L. S.	116
Steel Mill Packing Co.	71
Stephenson Mfg. Co.	85
Sterling Lubricator Co.	85
Stewart Heater Co.	97
Strong, Carlisle & Hammond Co.	82
Struthers-Wells Co.	107
Sturtevant Co., B. F.	96
System Co.	71
Toledo Pipe Threading Machine Co.	78
Trill Indicator Co.	87
Trimont Mfg. Co.	64
Triumph Electric Co.	106
Triumph Ice Machine Co.	110
Underwood & Co., H. B.	113
Union Steam Pump Co.	100
U. S. Mineral Wool Co.	73
Vanda Co.	68
Vilter Mfg. Co.	109
Vogt Machine Co., Henry	103
Walch & Wyeth	61
Walton Co., F. S.	86
Warren Steam Pump Co.	99
Watson & McDaniel Co.	94
Watson-Stillman Co.	64
Weber Co.	59
Webster & Co., Warren	55
Westinghouse Electric & Mfg. Co.	105
Wetherill & Co., Robert	113
Wheeler Condenser & Eng. Co.	99
Whitlock Coil Pipe Co.	96
Wickes Boiler Co.	104
Wiederholdt Construction Co.	91
Wilkinson Mfg. Co.	89
Williams & Co., J. H.	64
Williams Foundry and Machine Co.	86
Williams Valve Co., D. T.	73
Wing Mfg. Co., L. J.	90
Wisconsin Engine Co.	112
Yale & Towne Mfg. Co.	63
York Mfg. Co.	110


" Hot, Soft Water Coming from Hot Process Softener "
" Water in which Impurities are being precipitated by Hot Process Softener "

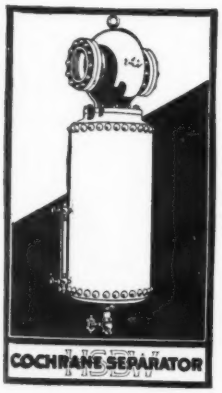
DRAW SOME WATER

from the reaction chamber of our "HOT PROCESS SYSTEM" OF WATER PURIFICATION and then draw some from the feed line.

The water from the reaction chamber is raw water in process of purification. It has just come down over the trays and has been heated boiling hot by the exhaust steam, which precipitates carbonates and eliminates gases, and has been mixed with the proper amount of reagent to throw down sulphates and chlorides and neutralizes acids. It is therefore cloudy and full of precipitated particles of scale-forming matter.

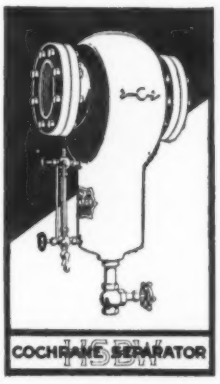
The water drawn from the boiler feed line leading from the "Hot Process System" is the same water rendered clear and pure by sedimentation in the settling chamber and by straining through the filtering medium. Water purified in the "Hot Process System" cannot form hard scale in the boilers. Hot, soft feed water saves 15% or more of the coal bill, 90% of the boiler cleaning bills and in some cases a like proportion of the boiler repair bills.

If you would like hot soft water of the clear kind for your boilers we would be glad to have you post us regarding your conditions and requirements so that we may have the opportunity of telling you what we can do and what it will cost you.



HARRISON SAFETY BOILER WORKS,

17th & Clearfield Sts., Philadelphia, Pa.



Classified Index to Articles Advertised

Air Compressors

Deane Steam Pump Co., Holyoke, Mass.
McGowan Co., John H., Cincinnati, O.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Riverside Engine Co., Oil City, Pa.
Scully Steel & Iron Co., Chicago, Ill.
Union Steam Pump Co., Battle Creek, Mich.
Westinghouse Traction Brake Co., Pittsburg, Pa.
Wisconsin Engine Co., Corliss, Wis.
York Mfg. Co., York, Pa.

Alarms, Water

Pittsburgh Gage and Supply Co., Pittsburgh, Pa
Reliance Gauge Column Co., Cleveland, O.

Alcohol Distillery Apparatus

Continental Natural Gas Alcohol Co., Wheeling, W. Va.

Arch, Back Combustion Chamber

McLeod & Henry Co., Troy, N. Y.
Mayville Specialty Mfg. Co., Mayville, Wis.

Arch, Boiler

McLeod & Henry Co., Troy, N. Y.

Arch, Boiler Door

Mayville Specialty Mfg. Co., Mayville, Wis
McLeod & Henry Co., Troy, N. Y.
Presbrey Fire Brick Wks., Taunton, Mass.

Asbestos Goods

Carey Co., Philip, Cincinnati, O.
Johns-Manville Co., H. W., New York.
Restein Co., Clement, Philadelphia, Pa.

Bars, Cylinder Boring

Underwood & Co., H. B., Phila., Pa.

Batteries, Storage

Westinghouse Machine Co., Pittsburg, Pa.

Belt Fasteners

Bristol Company, Waterbury, Conn.

Belting, Leather

Garlock Packing Co., Palmyra, N. Y.
N. Y. Belting & Packing Co., New York.
Reeves Pulley Co., Columbus, Ind.
Restein Co., Clement, Philadelphia, Pa.
Rhoads & Sons, J. E., Phila., Pa.
Robins New Conveyor Co., New York.
Sawyer Belting Co., New York.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belting, Rubber

Bowers Rubber Works, Oakland, Cal.
Diamond Rubber Co., Akron, Ohio.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.

Benders, Hydraulic

Watson-Stillman Co., New York.

Bending, Pipe

Harrisburg Pipe & Pipe Bending Co., Harrisburg, Pa.
National Pipe Bending Co., New Haven, Conn.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.
Whitlock Coil Pipe Co., Hartford, Conn.

Bends, Pipe

Harrisburg Pipe and Pipe Bending Co., Harrisburg, Pa.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Bends, Pipe—*Continued.*

Whitlock Coil Pipe Co., Hartford, Conn.

Blocks, Chain

Yale & Towne Mfg. Co., New York.

Blowers

Beggs & Co., James, New York
De Laval Steam Turbine Co., Trenton, N. J.
Green Fuel Economizer Co., Matteawan, N. Y.
McClave-Brooks Co., Scranton, Pa.
Ohio Blower Co., Cleveland, O.
Scully Steel & Iron Co., Chicago, Ill.
Sirocco Engineering Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Wing Mfg. Co., L. J., New York.

Blowers, Furnace

McClave-Brooks Co., Scranton, Pa.

Boilers

Babcock & Wilcox Co., New York.
Beggs & Co., James, New York.
Edge Moor Iron Co., Edge Moor, Del.
Erie City Iron Wks., Erie, Pa.
Fort Wayne Foundry & Machine Co., Fort Wayne, Ind.
Griffith & Wedge Co., Zanesville, O.
Heine Safety Boiler Co., St. Louis, Mo.
Keeler & Co., E., Williamsport, Pa.
Kewanee Boiler Co., Kewanee, Ill.
Morrin Climax Boiler Co., Brooklyn, N. Y.
Oil Well Supply Co., Oswego, N. Y.
Parker Boiler Co., Philadelphia, Pa.
Phoenix Iron Works Co., Meadville, Pa.
Robb-Mumford Boiler Co., South Framingham, Mass.
Rust Boiler Co., Pittsburg, Pa.
Struthers-Wells Co., Warren, Pa.
Vilter Mfg. Co., Milwaukee, Wis.
Vogt Machinery Co., Henry, Louisville, Ky.
Wetherill & Co., Robert, Chester, Pa.
Wickes Boiler Co., Saginaw, Mich.

Boilers, Second Hand

Wickes Boiler Co., Saginaw, Mich.

Books

American School of Correspondence, Chicago, Ill.
Hill Publishing Co., New York.
International Text Book Co., Scranton, Pa.
System Co., Chicago, Ill.

Boosters

Ridgway Dynamo & Engine Co., Ridgway, Pa.

Brick, Fire

C-O-Two Furnace Co., Syracuse, N. Y.
McLeod & Henry Co., Troy, N. Y.
Presbrey Fire Brick Wks. Taunton, Mass.

Building Materials, Fireproof

Carey Co., Philip, Cincinnati, O.
Johns-Manville Co., H. W., New York.

Castings, Brass and Iron

Homestead Valve Mfg. Co., Pittsburg, Pa.
Illinois Malleable Iron Co., Chicago, Ill.
McClave-Brooks Co., Scranton, Pa.
Ohio Brass Co., Mansfield, O.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Castings, General

Neemes Bros., Troy, N. Y.

Castings, Malleable

Jeffrey Mfg. Co., Columbus, O.

Cement, Asbestos

Johns-Manville Co., H. W., New York.
N. Y. Belting & Packing Co., New York.

Cement, Boiler

Smooth-On Mfg. Co., Jersey City, N. J.

Chimneys, Reinforced Concrete

Wiederholdt Construction Co., Chicago, Ill.

Chimneys, Steel Concrete

Weber Co., Chicago, Ill.

Clamp, Steam Joint

McCrea & Co., James, Chicago, Ill.

Clamp, Pipe

McCrea & Co., James, Chicago, Ill.

Cleaners, Mechanical

Lagonda Mfg. Co., Springfield, Ohio.

Cleaners, Tube

Andrews Mfg. Co., Thos., Rockaway, N. J.
Buckeye Boiler Skimmer Co., Toledo, Ohio.
Chesterton Co., A. W., Boston, Mass.
Garlock Packing Co., Palmyra, N. Y.
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa.
McCrea & Co., James, Chicago, Ill.
Pierce Co., Wm. B., Buffalo, N. Y.
Robertson & Sons, Jas. L., New York.
Scully Steel & Iron Co., Chicago, Ill.
Stewart Heater Co., Buffalo, N. Y.

Cleaners, Steam Flue

Henry Steam Flue Cleaner Co., Ashland, Wis.

Cleaners, Turbine Boiler Tube

Lagonda Mfg. Co., Springfield, Ohio.

Clocks

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Standard Gauge Mfg. Co., Foxboro, Mass.

Clutches, Friction

Reeves Pulley Co., Columbus, Ind.
Williams Fdry. & Mach. Co., Akron, Ohio.

Cocks, Air

Williams Valve Co., D. T., Cincinnati, Ohio.

Cocks, Blow-Off

Liberty Mfg. Co., Pittsburg, Pa.
Lunkenheimer Co., Cincinnati, O.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Cocks, Gage

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Huyette Co., P. B., Philadelphia, Pa.
Ohio Brass Co., Mansfield, Ohio.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
Reliance Gauge Column Co., Cleveland, O.

Cocks, Steam

Homestead Valve Mfg. Co., Pittsburg, Pa.
Schutte & Koerting Co., Philadelphia, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

Coils, Pipe

Fairbanks Co., New York.
National Pipe Bending Co., New Haven, Conn.

Compound, Boiler

Binghamton Boiler Compound Co., Binghamton, N. Y.
Bird-Archer Co., New York.
Buckeye Boiler Skimmer Co., Toledo, Ohio.
Coralline Drug & Chemical Co., New York.
Dearborn Drug & Chemical Co., Chicago, Ill.
Hawk-Eye Compound Co., Chicago, Ill.
Johns-Manville Co., H. W., New York.
Lagonda Mfg. Co., Springfield, Ohio.

Compound, Lubricating

Cook's Sons, Adam, New York.
Houghton & Co., E. F., Philadelphia, Pa.

Condensers

Alberger Condenser Co., New York
Anderson Co., V. D., Cleveland, O.
Baragwanath & Son, Wm., Chicago, Ill.
Deane Steam Pump Co., Holyoke, Mass.
Epping-Carpenter Co., Pittsburg, Pa.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Schutte & Koerting Co., Philadelphia, Pa.
Stewart Heater Co., Buffalo, N. Y.
Southwark Foundry and Machine Co., Philadelphia, Pa.
Wheeler Condenser and Engineering Co., New York.

Consumers, Smoke

Climax Smoke Preventer Co., Boston, Mass.

Controllers, Electric

General Electric Co., Schenectady, N. Y.
Westinghouse Electric and Mfg. Co., Pittsburg, Pa

Controllers, Feed Water

American Boiler Economy Co., Philadelphia, Pa.

Cooling Apparatus, Air

De La Vergne Machine Co., New York.
Triumph Ice Machine Co., Cincinnati, Ohio.

Cooling Plants

Schutte & Koerting Co., Philadelphia, Pa.

Cooling Towers

Alberger Condenser Co., New York.
Baragwanath & Sons, Wm., Chicago, Ill.
Wheeler Condenser and Engineering Co., New York.

Correspondence Schools

American School of Correspondence, Chicago, Ill.
International Correspondence Schools, Scranton, Pa.

Couplings, Clutch

Williams Fdry. & Mach. Co., Akron, Ohio

Covering, Pipe and Boiler

Carey Co., Philip, Cincinnati, O.
Houghton & Co., E. F., Philadelphia, Pa.
Johns-Manville Co., H. W., New York.
U. S. Mineral Wool Co., New York.

Covering, Pulley

Houghton & Co., E. F., Philadelphia, Pa.

Crabs

Yale & Towne Mfg. Co., New York.

Cranes

Yale & Towne Mfg. Co., New York.

Die Stocks

Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Curtis & Curtis Co., Bridgeport, Conn.
Loew Mfg. Co., Cleveland, O.
Oster Mfg. Co., Cleveland, O.

Draft Apparatus, Mechanical

Green Fuel Economizer Co., Matteawan, N. Y.
Schutte & Koerting Co., Philadelphia, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Wing Mfg. Co., L. J., New York.

Dressing, Belt

Cling-Surface Co., Buffalo, N. Y.
Dixon Crucible Co., Jos., Jersey City, N. J.
Garlock Packing Co., Palmyra, N. Y.
Harris Oil Co., A. W., Providence, R. I.

WEBSTER FEED WATER HEATER, PURIFIER AND FILTER

"NO more 'thoroughfare heaters' for me," said an engineer at a recent convention. "I've had two explosions with them now. After my 'thoroughfare' had been cut out of commission by means of the by-pass valves, I wanted to start it up again, so I opened the valve on the exhaust steam inlet but forgot the exhaust outlet. I'm still wondering how far that explosion could be heard—and how it missed me."

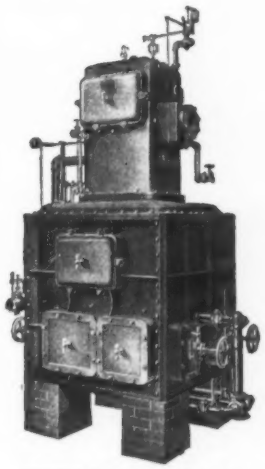
The WEBSTER Feed Water Heater Purifier And Filter

is now doing the work in that engineer's plant, and he has no fear of accident—the Webster is *not* a thorougfare heater. It uses just enough exhaust (in direct contact with the water) to gain the highest possible temperature, and allows no back-pressure on the engine. That's one reason why there are now 2,250,000 h.p. in successful use.

Webster Chemical Purifiers

automatically admit just enough chemical with the raw water and just enough exhaust steam to make the water harmless and pure, and send it into the boilers heated to the desired point. In every case they are adapted to individual conditions.

Send for Heater Booklet, 12-F and Chemical Purifier Booklet, 12-C.



WEBSTER CHEMICAL PURIFIER

Warren Webster & Co.

Camden, N. J., U. S. A.

24

Dressing, Belt—*Continued.*

Houghton & Co., E. F., Philadelphia, Pa.
Johnson Co., Henry, Jersey City, N.J.
Rhoads & Son, J. E., Phila., Pa.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.
Stephenson Mfg. Co., Albany, N. Y.
Walton Co., F. S., Philadelphia, Pa.

Dressing, Rope

Cling-Surface Co., Buffalo, N. Y.

Drills, Upright

Barnes Co., W. F. & John, Rockford, Ill.

Dust Collectors

Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos

American Engine Co., Bound Brook, N. J.
Clark Bros. Co., Belmont, N. Y.
Fort Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincinnati, O.
Westinghouse Electric and Mfg. Co., Pittsburg, Pa.

Educational

American School of Correspondence, Chicago, Ill.
International Correspondence Schools, Scranton, Pa.

Ejectors

American Injector Co., Detroit, Mich.
Beggs & Co., James, New York.
Lunkenheimer Co., Cincinnati, O.
Ohio Injector Co., Wadsworth, O.
Penberthy Injector Co., Detroit, Mich.
Schutte & Koerting Co., Philadelphia, Pa.

Engine Stops

Schutte & Koerting Co., Philadelphia, Pa.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.

Engineers and Contractors

Lammert & Mann, Chicago, Ill.

Engines, Automatic

American Diesel Engine Co., New York.

Engines, Blowing

Wisconsin Engine Co., Corliss, Wis.

Engines, Corliss

Bates Machine Co., Joliet, Ill.
Beggs & Co., James, New York.
Cooper Co., C. & G., Mt. Vernon, O.
Griffith & Wedge Co., Zanesville, O.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Providence Eng. Works, Providence, R. I.
Southwark Foundry and Machine Co., Philadelphia, Pa.
Vilter Mfg. Co., Milwaukee, Wis.
Wetherill & Co., Robert, Chester, Pa.
Wheeler Condenser & Engineering Co., New York.
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Buckeye Engine Co., Salem, Ohio.
De La Vergne Machine Co., New York.
Du Bois Iron Works, Du Bois, Pa.
Engberg's Electric & Mechanical Wks., St. Joseph, Mich.
Fairbanks Co., New York.
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Fort Wayne Fdry. & Machine Co., Fort Wayne, Ind.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Riverside Engine Co., Oil City, Pa.
Struthers-Wells Co., Warren, Pa.
Westinghouse Machine Co., Pittsburg, Pa.
Wisconsin Engine Co., Corliss, Wis.

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Wisconsin Engine Co., Corliss, Wis.

Engines, Oil

American Diesel Engine Co., New York.
De La Vergne Machine Co., New York.
Du Bois Iron Works, Du Bois, Pa.

Engines, Rolling Mill

Wisconsin Engine Co., Corliss, Wis.

Engines, Rotary

Ball-Cooley Engineering Co., New York.

Engines, Steam

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Ball Engine Co., Erie, Pa.
Ball & Wood Co., Elizabethport, N. J.
Bates Machine Co., Joliet, Ill.
Buckeye Engine Co., Salem, Ohio.
Clark Bros. Co., Belmont, N. Y.
Engberg's Electric & Mechanical Wks., St. Joseph, Mich.
Erie City Iron Wks., Erie, Pa.
Erie Mfg. & Supply Co., Erie, Pa.
Fitchburg Steam Eng. Co., Fitchburg, Mass.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Phoenix Iron Works Co., Meadville, Pa.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Shepherd Engineering Co., Williamsport, Pa.
Skinner Engine Co., Erie, Pa.
Southwark Foundry & Machine Co., Philadelphia, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
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Wisconsin Engine Co., Corliss, Wis.

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Gardner Gov. & Separator Co., Quincy, Ill.
Hoppes Mfg. Co., Springfield, O.
Ohio Blower Co., Cleveland, O.
Patterson & Co., F. L., New York.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Whitlock Coil Pipe Co., Hartford, Conn.

Fans, Electric

Crocker-Wheeler Co., Ampere, N. J.
Fort Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
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Triumph Electric Co., Cincinnati, O.
Westinghouse Elec. and Mfg. Co., Pittsburg, Pa.

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Sirocco Engineering Co., New York.
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Jeffrey Mfg. Co., Columbus, O.

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Davis Regulator Co., G. M., Chicago, Ill.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Lunkenheimer Co., Cincinnati, O
Myers & Bro., F. E., Ashland, O.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.

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Beggs & Co., James, New York.
Eclipse Feed Water Heater and Purifier Co., Appleton, Wis.
Keystone Chemical Co., Philadelphia, Pa.

Filters, Oil

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Houghton & Co., E. F., Philadelphia, Pa.
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Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
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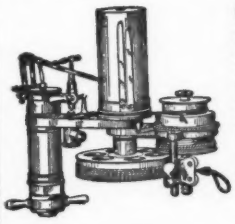

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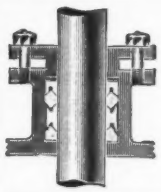

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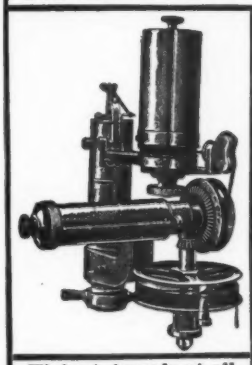

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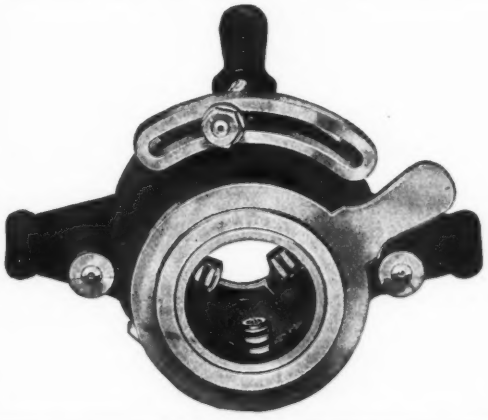

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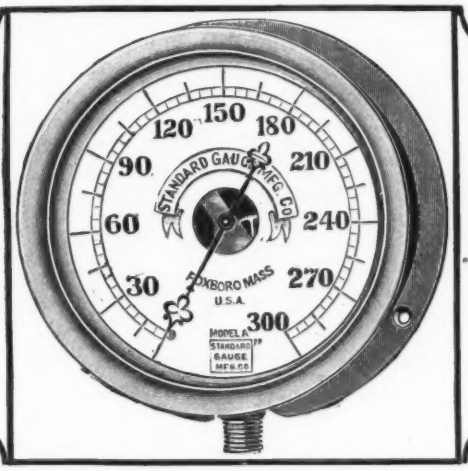

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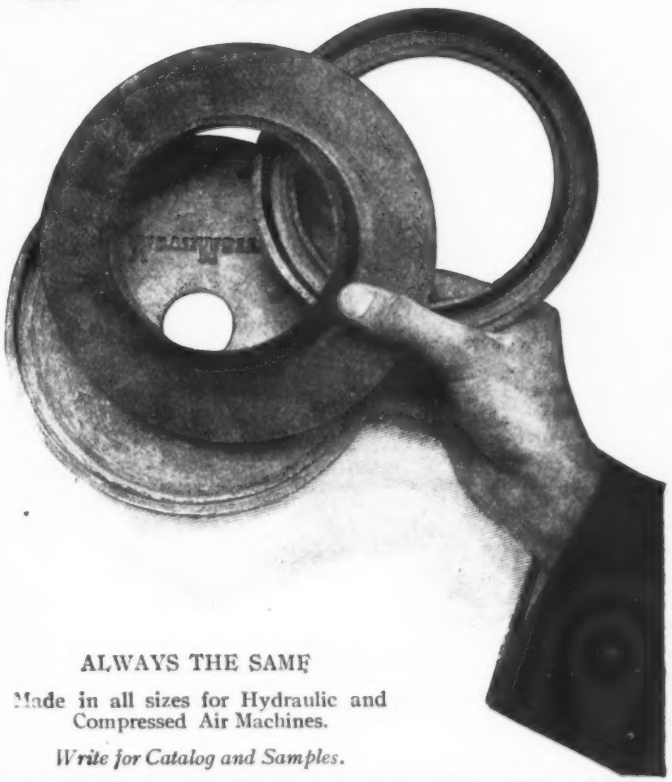

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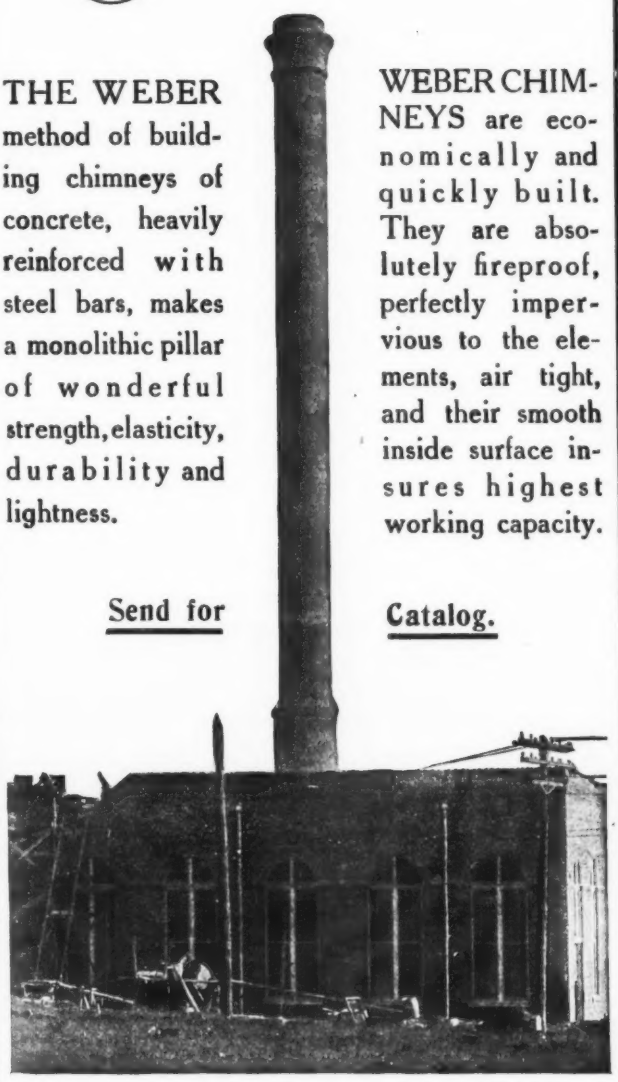

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See Tubing

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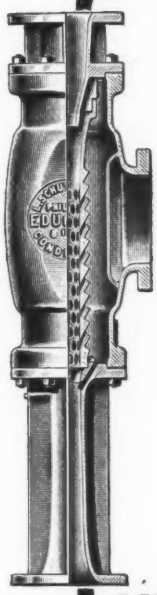

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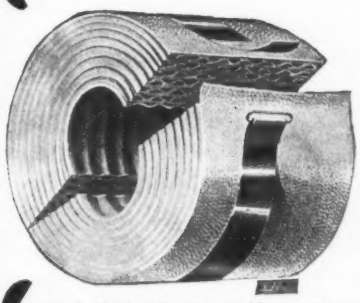

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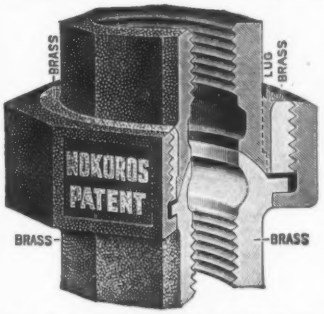

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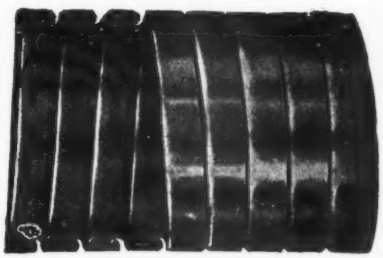

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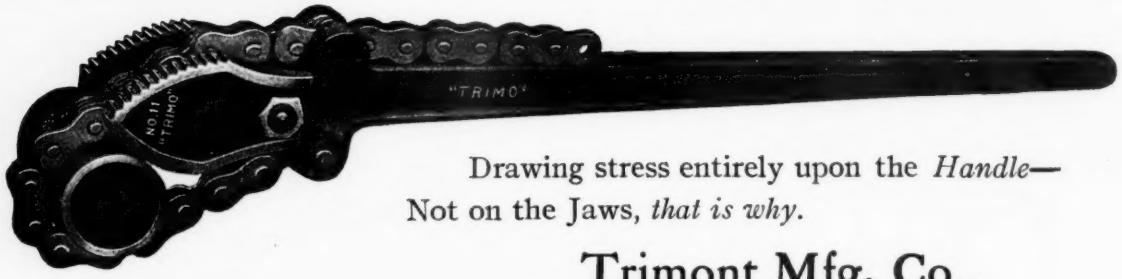

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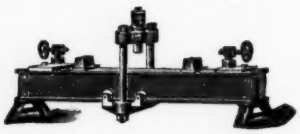

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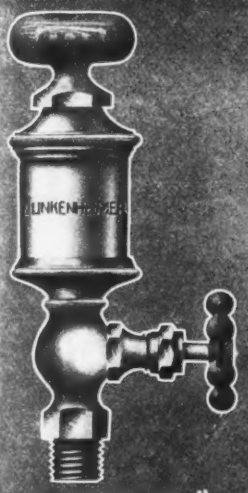

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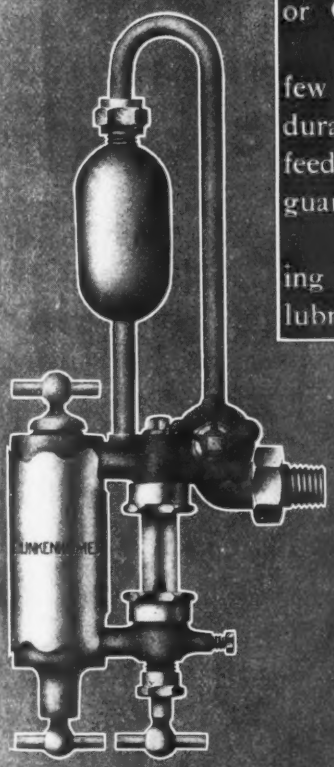

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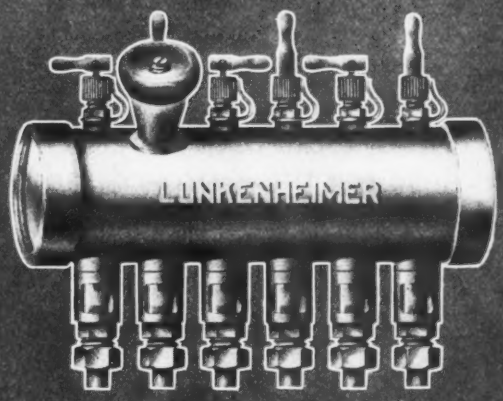

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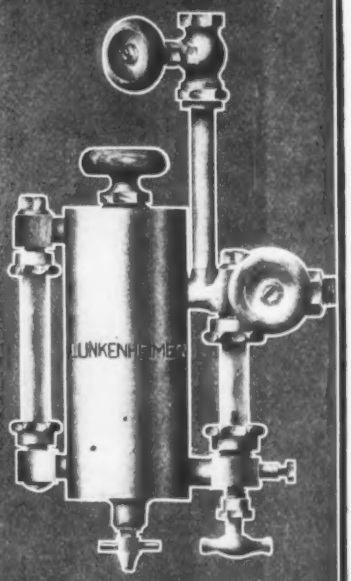

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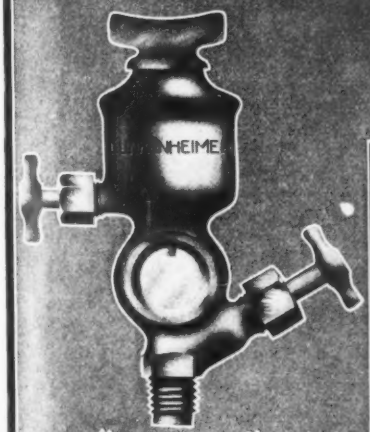

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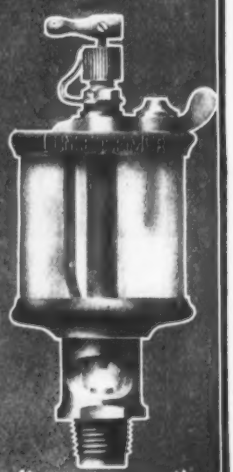

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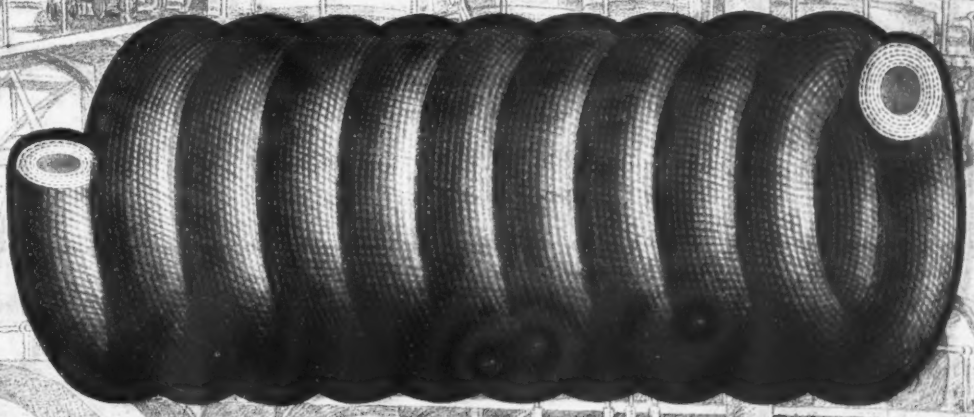

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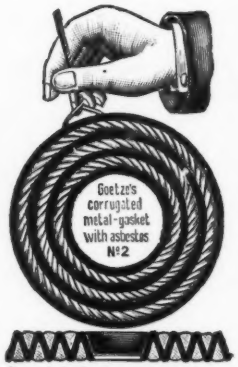

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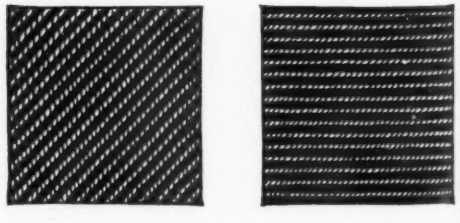

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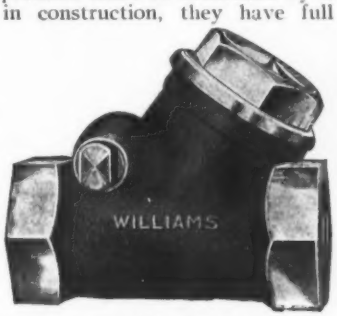
are excellent valves for use on boiler feed lines or any other place where the pressure must be controlled by a check valve. Heavy in construction, they have full and unobstructed passage through body which greatly reduces friction and necessarily prolongs the life of the valve. If you want higher valve efficiency at less cost—order Williams. They are strictly guaranteed for 200 pounds pressure.



Send us a postal for the new Williams catalog.

THE D. T. WILLIAMS VALVE CO.
904-910 Broadway, CINCINNATI, OHIO
4

BLACK SQUADRON

A Cancos Santa Claus.

We'll send a "Santa" of our own
out Christmas Eve this year,
To carry just the articles
that please an engineer.
She's neat, and sweet, and should you
meet her, this is what she brings:
CANCOS METAL POLISH and
BLACK SQUADRON PACKING RINGS.

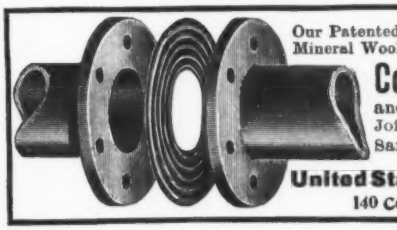
The 4 Wedge PACKING

Try it in the stuffing box that always leaks — one where no other packing stands a chance. That's where the four wedge construction makes good. It enables BLACK SQUADRON PACKING to respond perfectly to every inequality of a rod or stem with minimum friction, and only finger tightening of the gland nuts. Best materials throughout — every particle lubricated. Keeps rods in perfect trim. Write for booklet.

Cancos Metal Paste Polish

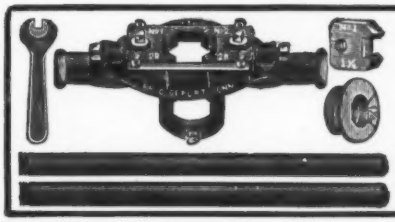
Cost only ¼ that of liquid polishes; can't scratch, no acids, no explosives, no stains or bad odor on hands. Makes oldest metal shine like new with magical ease and quickness. Write for free sample.

CANCOS MANUFACTURING CO.
Philadelphia, Pa.
102 High St., Boston, Mass. 525 Third Ave., Pittsburg, Pa.
305 Plowman St., Baltimore, Md.



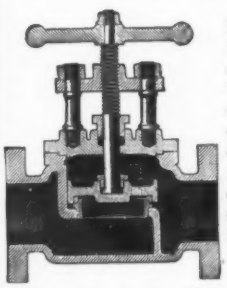
Our Patented Mineral Wool **Pipe Covering and Copper Gaskets** Save Steam and Make Absolutely Tight Joints. Best and Cheapest. Samples Free.

United States Mineral Wool Co.
140 Cedar Street, New York



STOCKS AND DIES
PIPE MACHINES,
PIPE CUTTERS,
VISES.
Manufactured by
The Armstrong Mfg. Co.
287 Knowlton St.,
BRIDGEPORT, CONN.

"BELLVILLE VALVES"

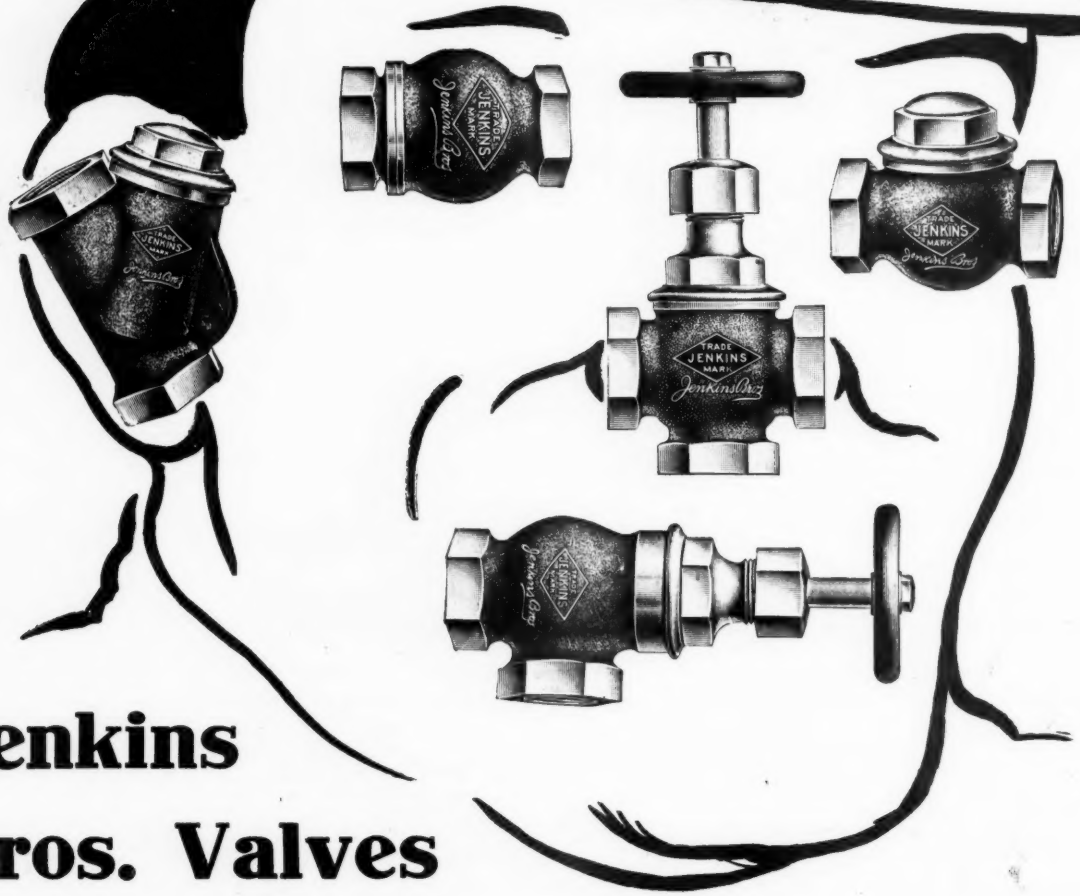


have the seat on the outside of an inverted cone where the direct current of steam does not come in contact with it, preventing all chance of wire drawing. Other features in catalog.

Heavy, Compact, Durable,
no marring by pipe tongs.

Eastwood Wire Manufacturing Co.,
BELLEVILLE, NEW JERSEY.

Features That Cannot Be Overlooked



Jenkins Bros. Valves

are made of the best steam metal; they are most carefully and skillfully manufactu ed; they are the most durable valves on the market; they have full opening; interchangeable parts; can be repacked when wide open and under full pressure—those are a few features of Jenkins Bros. Valves. Let us tell you more.

Write For The Catalog.

JENKINS BROS.

71 John Street, New York, N. Y.
35 High Street, Boston.
133 No. 7th Street, Philadelphia.
226-228 Lake St., Chicago.

Nelson Valves

Mechanically, the characteristic advantage of Nelson Gate Valves lies in the independent, tapered double disc mechanism, so simple that it cannot be wrongly assembled, and yet so automatically flexible as to provide conformity to any distortions caused by unavoidable strains.

The practical advantage is evidenced in their efficient, steady service. They save expense by avoidance of costly and troublesome repairs and by preventing waste of water, steam and fuel.

Each valve is guaranteed for its rated service.

Nelson Valves are made in the Gate, Globe, Angle and Check types, in all Sizes, of Iron, Bronze or Steel, for All Pressures, for Any Service.

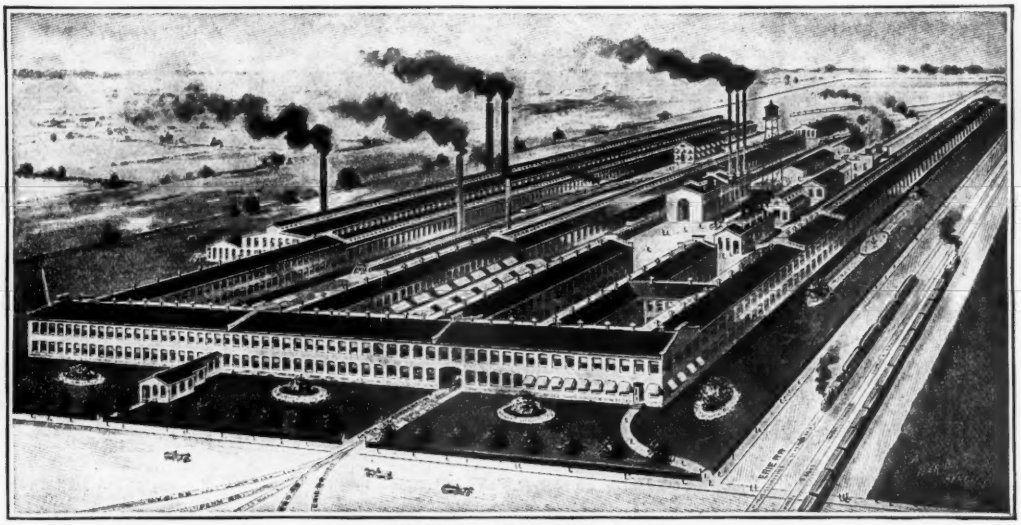
The Nelson Valve Company

Philadelphia

NEW YORK:	Hudson Terminal Bldg.
CHICAGO:	40 Dearborn Street
PITTSBURGH:	525 Third Avenue
MINNEAPOLIS:	622 Andrus Building
SAN FRANCISCO:	Atlas Building
BUTTE, MONT.:	56 E. Broadway

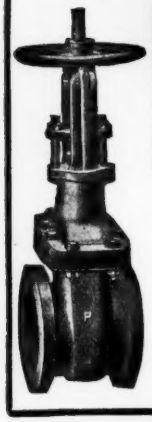
PITTSBURGH IRON BODY GATE VALVES

have been thoroughly tested under the most severe conditions known and have proved that they work under all pressures with less wear on the faces of the discs and seats than any other valves made.

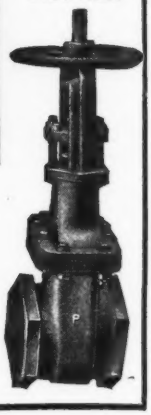


WORKS, BARBERTON, O.

ALWAYS SPECIFY **P** VALVES AND FITTINGS.



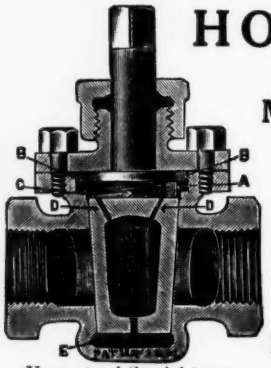
ALWAYS SPECIFY **P** VALVES AND FITTINGS.



They are made standard for 150 lbs. and extra heavy for 250 lbs. working pressures. They can be furnished screwed, flanged or hub end; with by-pass, spur or bevel gearing and are suitable for steam, gas or water. They are made with outside screw and yoke or non-rising spindles. We have many thousands of them in use in all parts of the country and have never had a complaint or a valve returned.

PITTSBURGH VALVE & FITTINGS COMPANY,

General Offices and Works: BARBERTON, O. We Manufacture all kinds of Valves and Fittings.



Homestead Straightway Balanced Plug Valve, Locks by Quarter Turn.

HOMESTEAD

Three-Way

METALLIC VALVES

require but one-third turn of plug to lock either shut or open, for any pressure.

Ask us to forward our valve *Booklet.*

HOMESTEAD VALVE MFG. CO.,

PITTSBURG, PA., U. S. A.

A UNION

SPHERICAL IN SHAPE
THOROUGHLY GROUND
SELF-SEATING. WRITE.

The Jefferson Union Co.,

31-37 Fletcher Street, Lexington, Mass.

THE MASON REDUCING VALVE,

which is easily adjusted with a key, preserves any desired reduced pressure of air, steam or water, regardless of the initial pressure. CATALOG ?

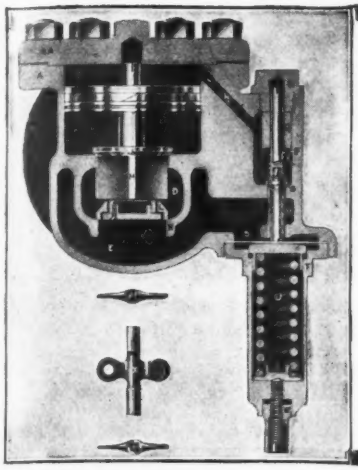
The Mason Regulator Co., Boston, Mass.

EVERLASTING BLOW-OFF VALVE

Straight-through flow. No stuffing-box. Easily operated. Self-cleaning; self-grinding seats. Easily repaired. Send for descriptive booklet and prices.

SCULLY STEEL & IRON CO.,

CHICAGO



OUT OF THE PATH OF INITIAL STEAM

EVERY ENGINEER WHO HAS HAD TROUBLE WITH REGULATING VALVES, ON ACCOUNT OF CHIPS AND SCALE INTERFERING WITH THE OPERATION OF THE CONTROLLING VALVE, WILL INSTANTLY REALIZE THE BIG ADVANTAGE OF THE COLLIN REGULATING VALVE IN WHICH THIS VITAL PART "O" IS ABSOLUTELY PROTECTED FROM FOREIGN MATTER. - - - - - -

CATALOGUE P-B, DESCRIBES IT IN DETAIL COPY MAILED ON REQUEST.

The Ohio Brass Co., Mansfield, Ohio, U.S.A.

NEW YORK, 30 CHURCH ST. CHICAGO, 277 DEARBORN ST. SAN FRANCISCO, 138 FRONT ST.

VALVES

Makes no difference what kind of a Valve you want, how you want it made or where you want it shipped, we can supply it on shortest possible notice.

We manufacture valves and pipage equipment of every description, for all kinds of plants, Steam Separators, Tuyere Cocks, Brass Unions, Etc. Also make Pipe Bends, and do all kinds of Pipe Fitting, either assembled or ERECTED.

SEND FOR CATALOG

PITTSBURGH VALVE FOUNDRY & CONSTRUCTION CO.

Pittsburgh Cleveland New York Boston Birmingham, Ala.

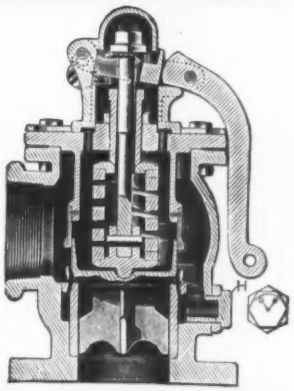
Sent on Trial

The Ashton Improved Lock-up Pop Safety Valve differs from all others in that it automatically adjusts itself to the wear thus insuring the longest service with the least repair. This is but one of many good features. Ask for our catalog.

The Ashton Valve Co.

Boston New York Chicago

St. Johns House, London, E. C.



You are in good company

When joining the users of Dexter Valve Reseating Machines.

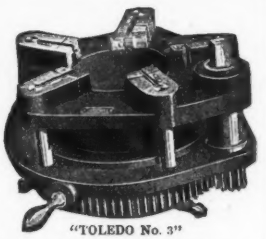
Every ship in the U. S. Navy, Railroads and Steamship Companies, Mining and Steel Industries, Chemical Works, Breweries, Public Institutions, Hotels, Department Stores, including the Diamond Mines of South Africa, and Sugar Mills in the remote parts of the South, keep their valves tight with these machines.

You can easily satisfy yourself regarding joining the list by ordering a machine on 30 days' trial, use it all you want to and then return it at our expense if you care to get along without.

Send for catalog P illustrating these machines.

The Leavitt Machine Co.,
Orange, Mass., U. S. A.

Dead Sure Die Service

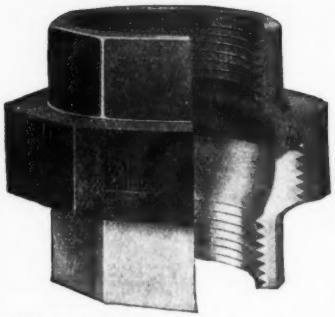

"TOLEDO No. 3"

is one of the many money-saving advantages which comes from using

TOLEDO PIPE THREADING DEVICES.

There is a set of dies provided for each size of pipe. With the "Toledo" it is easy to thread an 8" pipe. Write for full particulars.

THE TOLEDO PIPE THREADING MACHINE CO.
TOLEDO, OHIO, U. S. A.


"KEWANEE" The union with no inserted parts.

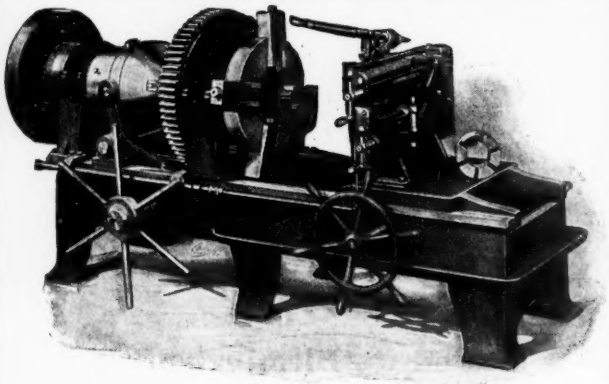
That's the point—the brass-to-iron thread connection and seal. It has made "Kewanee" Unions famous the world over by eliminating leaks, rust, hammering and sticking.

WRITE

National Tube Co.,
Pittsburgh, Pa.

District Sales Offices:

Atlanta	New Orleans	Pittsburgh	St. Louis
Chicago	New York	Portland	Salt Lake City
Denver	Philadelphia	San Francisco	Seattle



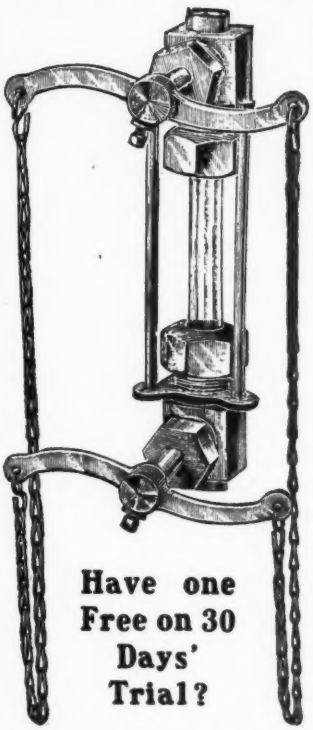
Pipe Machines For The Power Plant

We can furnish any size your plant may require, either belt or motor drive, and we want your inquiries.

Get the Catalog No. 17.

Bignall & Keeler Mfg. Co.
Edwardsville, Ill.

Like To Be Boiled?


Have one Free on 30 Days' Trial?

Well your time is coming—sooner or later a gauge glass will break, then you will wish for

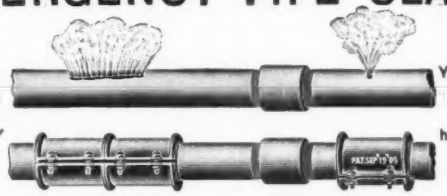
The "Huyette" Quick Closing Water Gauge.

Tell you what we will do—we'll protect you from scalding free of charge for 30 days, while you try our gauge, after that if you think it cheaper to take chances return the gauge and it will not cost you a cent. Circular?

The Paul B. Huyette Co.,
2025 Betz Bldg., Philadelphia, Pa.

PIPE REPAIRS FOR ANY CONDITION.

EMERGENCY PIPE CLAMP



TO REPAIR SPLITS AND RUST HOLES.

We manufacture the **CLIMAX STEAM JOINT CLAMP** to repair leaks at pipe joints, the **MODEL FLANGE CLAMP** for leaks between flanges, and the **H H STEAM TRAP**, simplest and best made.

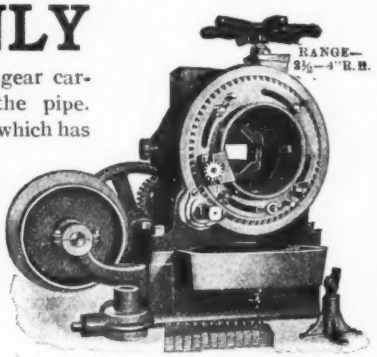
No. 2 *SEND FOR CATALOG.*

JAMES McCREA & CO., 61 to 65 W. Washington St., Chicago.

THE ONLY

machine with receding gear carrying the dies onto the pipe. THE ONLY machine which has *shell* adjustment for taking up wear. One man operates it with better results than four men using the old-style stock and die.

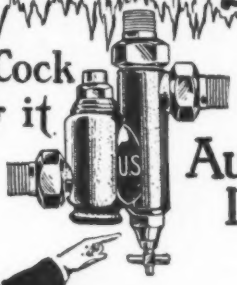
Write for Catalog.



THE CURTIS & CURTIS CO., 85 Garden St., Bridgeport, Conn.

No Freezing Here

The Drip Cock prevents it



U.S. Automatic Injector

The Drip Cock of the U. S. Automatic prevents freezing; prevents overheating of suction pipe; prevents jet "liming up" when steam or check valve leaks; *prevents destruction of hose on traction engines* by heat from hot water, and has many other exclusive advantages fully explained in our

Engineer's Red Book

sent free on request.

AMERICAN INJECTOR CO.
Detroit, Mich., U. S. A.

Chicago Automatic Injector

Chicago Automatic Injectors

Prove their Quality in Actual Operation

No boiler feeding troubles when you have a powerful Injector that is built for service.

The Chicago Guarantees a Full Boiler when you want it

It is positive in its work and has nothing to get out of order. Built unusually strong.

THE BEST PROTECTION FOR BOTH BOILER AND ENGINEER

You cannot afford to be without it. It makes the power plant complete.

THE CHICAGO EJECTOR, a powerful little instrument for elevating, forcing and conveying liquids. Does marvelous work with but little steam.

Write for description and catalog of both the Chicago Injector and Ejector.

THE OHIO INJECTOR COMPANY,

The World's Greatest Injector Manufacturers.

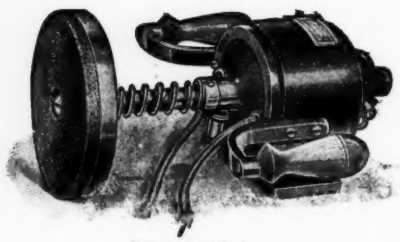
WADSWORTH 110 Main Street **OHIO, U.S.A.**

Chicago Ejector

HAVE YOU B. & W. BOILERS?

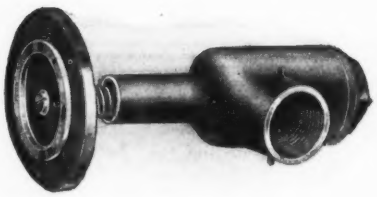
If so, don't clean the header faces, caps and nuts with hammer and chisel. It's slow tedious work, and the chisel may turn up "feather edges" on the contact surfaces. That means leaks afterward.

THE LAGONDA AUTOMATIC RESEATING MACHINE



Electric Motor.

does the work quicker, better and without the "elbow grease" required by the old method. A mere touch of the emery stone or cloth disc (interchangeable) is sufficient to thoroughly clean and polish the header surfaces. The faces of caps and nuts are cleaned by holding against the emery stone. The machine is secured to a bench for this purpose.



Water Motor.

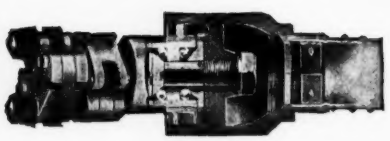
With this machine you can easily clean all contact surfaces of a 108-tube B. & W. Boiler in a very short time. In the St. Louis Exposition boiler plant *one* operator did more work in *one* day with this machine than *four* men did by hand in *four* days.

Get one on trial, and if you are not convinced, send it back.

THEN ABOUT CLEANING THE TUBES

No matter if you have one boiler or a hundred, whether the scale is thick or thin, like chalk or like flint, there's a

WEINLAND BOILER TUBE CLEANER



that's just right. For ordinary scale, the *Weinland Wing Head Cleaner* is the latest and greatest. It's driven by the best ball or thrust bearing turbine made, or if you have compressed air, we furnish a slick rotary motor for driving.

For hard thick scale that's an impossibility for any other cleaner, *The Weinland Mechanical Cleaner* will do the work and save the tubes. It also saves time and money wherever there is such cleaning to do.

Which do you want to know more about?

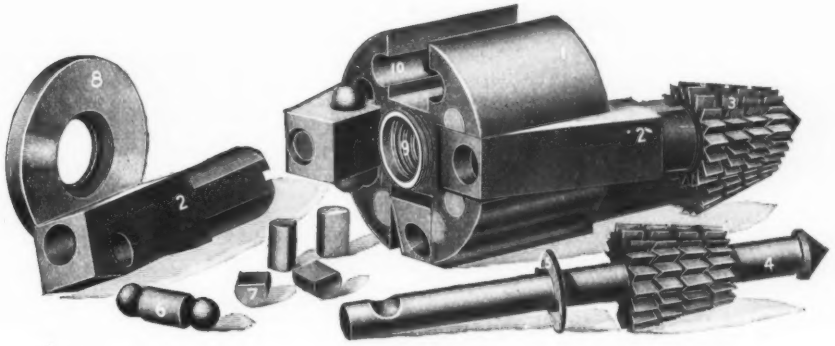
THE LAGONDA MFG. CO., Springfield, O.

Makers of Lagonda Automatic Cut-Off Valves, Reseating Machines and Tube Cutters.

New York Philadelphia Pittsburg Chicago San Francisco Birmingham St. Paul Toledo London

[82]

THEY'RE SELLING AS FAST AS WE CAN MAKE 'EM



The "Cyclone" Cleaner

reduces the cost of cleaning fully 75%. It never floods the boiler room or destroys the furnace brick work. Anyone can handle it. Can be driven by either compressed air or steam. The handiest, most satisfactory and useful tool of its kind on the market.

The "Norivet" Head

Here's just what you've often wished for—a cleaning head that is held together without the use of rivets. Think of it! All the parts are *locked* in place. You can put it together *by hand* in a few minutes; no tools required.

The **"Norivet"** is fast taking the places of all other types of cleaner heads. It's a *convenient time saver*—one that you should certainly try.

WRITE FOR FULL PARTICULARS

LIBERTY MANUFACTURING COMPANY,

6509 Susquehanna Street, Pittsburg, Pa.

In The Bearing

Dixon's Flake Graphite reduces friction by supplying the "positive principle" in lubrication impossible with oil or grease alone. It fills up all depressions and brings the surfaces as near as possible to a state of perfect smoothness, thereby preventing cutting and seizing.

DIXON'S Flake Graphite

In The Cylinder

Dixon's Flake Graphite prevents cutting and scoring, lengthens life of piston packing and assures smooth valve motion and uniform steam distribution.

Let us send you a free sample can, No. 94-C. It will show you a sure way to save.

JOS. DIXON CRUCIBLE CO.,
JERSEY CITY, N. J.

GRAPHLIO
Makes Your Oil Go Twice As Far

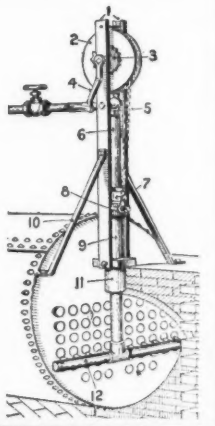
It is a pure Crystalline Graphite—an impalpable powder, free from grit or dirt. Mixed with any lubricating oil [in the proportion of about 1 to 200] **it remains in suspension** and doubles the efficiency of the oil.

It costs about 5 cents per gallon to graphitize your oil with "Graphlio," and the oil can be used in your regular oiling systems. *Write.*

Walter D. Carpenter & Co.
39 Cortlandt St., New York

Clean Flues Without Labor

by putting a Henry Steam Flue Cleaner on your boiler. It's guaranteed to do the business in 5 minutes by simply turning a crank and opening a valve. It blows the soot with the draft. *Write for descriptive matter.*



Live Agents Wanted

The Henry Steam Flue Cleaner Co.,
Ashland, Wis.

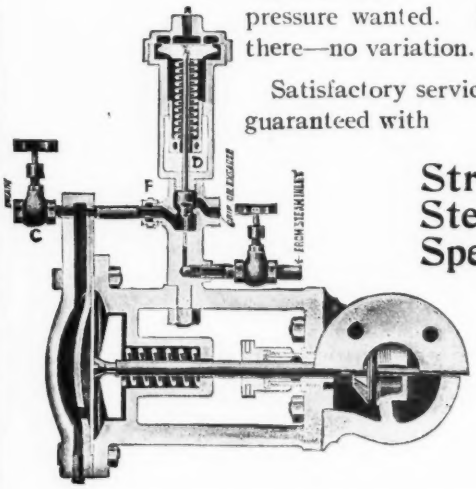
With our

Reducing Valves

4/S

you do not need to consider the initial pressure. Set the valve at the pressure wanted. It's always there—no variation.

Satisfactory service is always guaranteed with



Strong's Steam Specialties

May we send our complete Catalog A?

The Strong, Carlisle & Hammond Co.,
342 Frankfort Ave., - Cleveland, Ohio

88 Broad Street, BOSTON
54 No. 6th Street, PHILADELPHIA
261 Centre Street, NEW YORK

HARRIS

(TRADE MARK—REG. U.S. PAT. OFF.

OILS

THE OILS THAT SAVE MOST

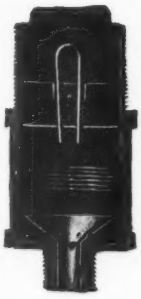
Not in first cost, but in the end. HARRIS OILS are unequalled for QUALITY, UNIFORMITY and ECONOMY. Because HARRIS VALVE and ENGINE OILS possess the greatest degree of lubricating power on which depends economy in amount required and best protects the surfaces from wear and corrosion. Also perfectly adapted for every lubricating condition and requirement.

The Saving is Guaranteed.

A. W. HARRIS OIL CO.

323 So. Water St., PROVIDENCE, R. I.

The "Philadelphia" Grease Cup



Automatic application of grease to the bearing without the use of spring compression. : : : :

Nature Supplies the Feeding Force in the Form of Compressed Air. : : : : : :

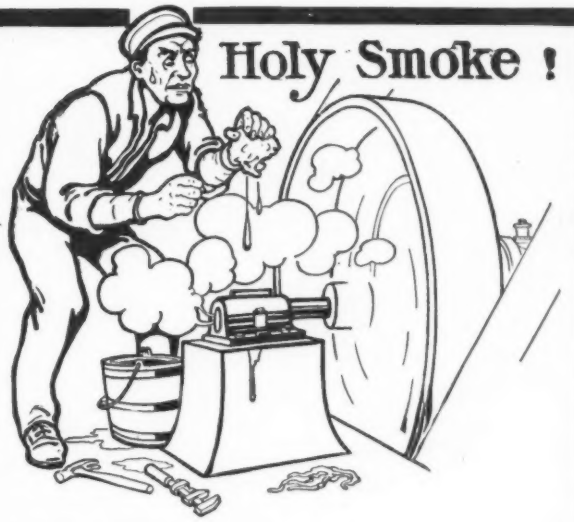
With many thousands of the "Philadelphia" Grease Cups in successful operation, on machinery of almost every description, we offer a system of lubrication which, for simplicity, cleanliness, economy, reliability and efficiency has no equal.

The "Philadelphia" Cup is not merely "as good as any other:" IT IS THE BEST, and we are prepared to prove our claim for actual superiority. There are more reasons for its practical success than we have room to mention here.

Write for catalogue and full information

The Philadelphia Lubricator & Manufacturing Co.

The Bourse (Exhibition Dept.), Philadelphia, Pa.



Holy Smoke!

DON'T swear at the bearing, it's all your own fault when you have been using oil. Oil is thin when it's cold, and thinner when it's hot. To do any good, it must be supplied to the bearing in a steady stream.

Then, you go to the other extreme and use grease. Now, grease is only oil thickened with talc, animal fats, rosin or waxes, to give it body. When things get hot enough so that the grease melts, it becomes thin like oil, except that it leaves the "filler" inside of the bearing, and this "filler" increases friction, wasting power.

Keep the bearings cool by using

TRADE MARK NON-FLUID OILS REGISTERED IN UNITED STATES PATENT OFFICE

Non-Fluid Oils are a fine mineral oil condensed to prevent dripping and spattering, but containing nothing that will gum or increase friction.

Try NON-FLUID OILS at our expense and you'll buy them to cut down yours.

Free sample sent by paid express.

Originators and Sole Manufacturers

N. Y. & N. J. Lubricant Company

Dept. A

14-16 Church St., New York

Chicago Office and Warehouse, 309 ILLINOIS STREET,

N. Y. & N. J. LUBRICANT CO.,
14-16 Church St., New York City

Please send FREE sample of NON-FLUID OIL for the following purpose:

.....
State kind of machinery or engine.

.....
State on what part Sample is to be used.

(Name) .....

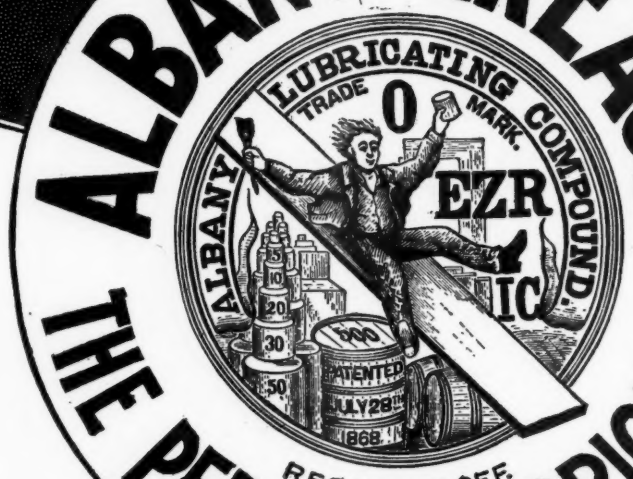
(Address) .....

22

COSTS LESS

ALBANY GREASE

WORKS BEST



THE PERFECT LUBRICANT

REG. U.S. PAT. OFF.

Send for free ALBANY GREASE CUP and liberal samples of ALBANY GREASE

ADAM COOK'S SONS, NEW YORK

THE LARGEST PLANT ON EARTH ADOPTS THE *WHITE STAR OIL FILTER*

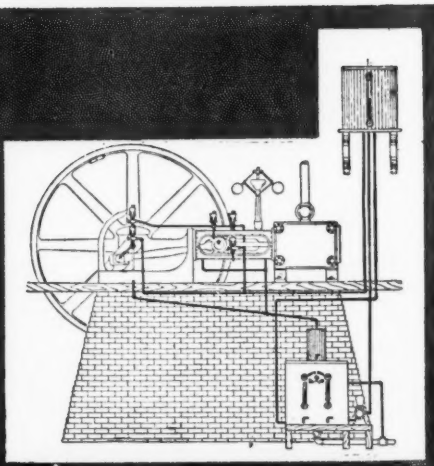
The Engineering Profession knows that the GARY, INDIANA, plant of the Indiana Steel Company, the largest commercial power installation ever undertaken, has been designed as to every detail of equipment by expert engineers. The selection of the "White Star" emphasizes the already widely accepted fact that highest efficiency is insured by its use.

Manufactured by

THE PITTSBURGH GAGE & SUPPLY CO.,

PITTSBURGH, PA.

Write for Catalogue and prices



THE GLOW OF ACHIEVEMENT
WHITE STAR
IN THE REALM OF SUPREMACY

40% To 60%

in oil bills is saved and far better results are insured by using

A STERLING FORCE FEED LUBRICATOR

which furnishes machines with most perfect lubrication possible. *Catalog?*

STERLING LUBRICATOR CO.
3 Frank St., Rochester, N. Y.

Detroit Improved Standard Lubricator

Some One

of our 337 different styles and sizes of sight-feed lubricators will fill any requirement you may have.

When ordering, insist on getting the genuine Detroit.

Write for a catalog of the most complete line of oiling devices for all purposes.

DETROIT LUBRICATOR COMPANY.
Detroit, U. S. A.

Shultz Aqua Waterproof Belting

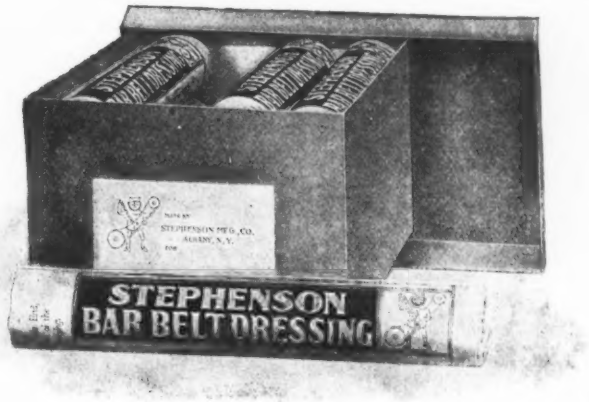
will do your work and do it right in damp places, or where exposed to steam.

Aqua leather as well as the cement is absolutely impervious to surrounding conditions. The plies won't separate from moisture.

OIL-STEAMPROOF "Aqua" WATERPROOF

Tell us your belt troubles. Get an Aqua Belt for 60 days' free.

SHULTZ BELTING CO.
ST. LOUIS, MO.
NEW YORK BOSTON (26-A) PHILADELPHIA



DON'T LET $4.80

Stand between you and healthy, long-lived, dependable belts.

Ask your dealer for a box of STEPHENSON Bar Belt Dressing, and see how quickly and gratefully your belts will respond to good treatment.

The results will delight your heart and your check book.

Be sure our registered Trade-Mark, The man with the Cog-Wheel Face, is on each Pound Stick.

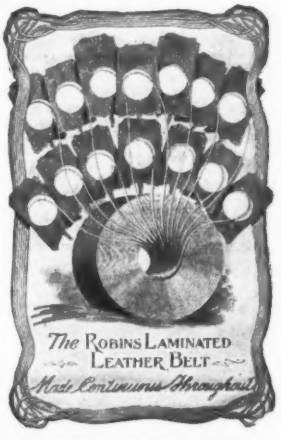
Don't confuse the Brands:

RED Label Brand for Leather Belts
GREEN Label for Rubber and Canvas

$4.80 for a 12-lb. box

Of Dealers Everywhere, or

STEPHENSON MFG. CO.
ALBANY, N. Y.



Practically Akin to a Positive Drive

ROBINS LAMINATED LEATHER BELTING

The only logical choice between direct connection and the belt.

Indispensable for High Speed Heavy Duty Service

Made from continuous units cut in strands of full roll length from the finest selected oak tanned belting butts. The strands are cut to gauge and the width determines the thickness of the belt when they are laid on edge and laminated together. Every strand is stretched independently to the full elastic limit guaranteeing a belt which is practically *non-stretchable*. **NO LAPS, NO PLIES, NO CEMENT**—joined endless upon the pulleys with a neat and simple splice which holds the gauge, balance and strength of the belt intact.

WRITE FOR CIRCULAR No. 2.

ROBINS NEW CONVEYOR COMPANY
Factory: 168 Duane St., New York.
New York: 38 Wall St. Chicago: Old Colony Bldg.

"DUXBAK" WATERPROOF

DUXBAK BELTING
TRADE MARK

Leather Belting can be soaked in soapy water any length of time without its joints or fibre being affected.

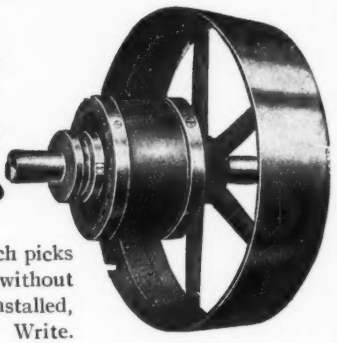
"DUXBAK" STEAMPROOF can be boiled without being injured in the least. Either sent on approval for your test.

Chas. A. Schieren Company
ESTABLISHED 1868.

Tanners, Belt Manufacturers. 69 Cliff St., New York.

Chicago, 84-86-88 Franklin St. Pittsburg, 240 Third Ave. Boston, 186-188 Lincoln St. Denver, 1622 Wazee St. Philadelphia, 226 North Third St. Brooklyn, N. Y., 13th St. and 3rd Ave. Hamburg, Germany, Auf dem Sande 1. OAK LEATHER TANNERIES, Bristol, Tenn.

Durable, Reliable, Noiseless



The Akron Friction Clutch picks up the load gradually without shock or jar, is easily installed, adjusted and operated. Write.

The Williams Foundry & Machine Co.
Successors to the Akron Clutch Co. AKRON, OHIO.

Belting Logic—If best Leather Belting costs per sq. ft. $1.00, best Rubber Belting 60c., and best Stitched Canvas Belting 40c., and with Leather showing 25% and Rubber 50% of the strength of **Best Stitched Canvas Belting,** wouldn't it be good policy for you as a practical man to investigate the merits of our product? Send for Book "C."

SAWYER BELTING COMPANY, CLEVELAND, OHIO.

SAGINAW MANUFACTURING CO.,
SAGINAW, MICH., U. S. A.
MANUFACTURERS OF
GILBERT WOOD SPLIT PULLEYS.
New York Branch, 88 Warren Street.
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Sales Agencies in all principal cities.
Cable Address, "Engrave" A. B. C. and Lieber's Code.

RHOADS LEATHER BELTING

Thoroughly Stretched

J. E. Rhoads & Sons
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HAMBLET & HAYES CO., EASTERN AGENTS, 105-111 SUMMER ST.
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THERE'S NO LETTING GO WHEN OXOILOX GETS BUSY.

F. S. WALTON CO., Philadelphia.
Gentlemen:—Kindly send us free of all charge, a sample can of OXoilOX, the perfect belt dressing.

Name..... Name of Firm.....

Address..... Number of Belts..... Average Size.....

F. S. WALTON CO., Philadelphia, Pa.
Pressers and Refiners of all grades of Neatsfoot Oil.

BUT IT'S THE BELT THAT DOES THE GRIPPING

If a belt has been thoroughly treated with **OXoilOX** you can't make it slip. Run it at full load and full speed—it clings to the pulleys like a chain to the sprocket. **OXoilOX** gives new strength to **old tired belts.** It drives out the "sticky stuff" with which they are usually saturated; makes them clean, pliable and tough. They do **more work** and do it **better.** For **new belts** the best possible start in life is a treatment with **OXoilOX.** It takes the stiffness out; restores the vitality lost in tanning, and helps them get right down to work. Whether old or new, a belt treated with **OXoilOX** adheres so closely to the pulleys that air is absolutely excluded and it's the vacuum thus formed that enables it to **run slack** at **full load without slipping.** Write for sample.

If You Have Bad Feed Water

every dollar invested in BIRD-ARCHER BOILER COMPOUNDS saves from one to three more dollars in fuel. By preventing every trace of scale the compound further does away with shut-downs and the hard labor of cleaning.

You cannot better preserve the life and strength of the boilers, and help the attendants.

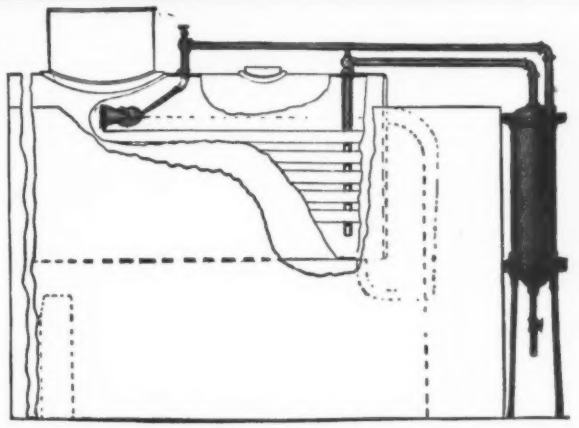
If a six months' trial doesn't remove all old scale, and prevent further scale formation or any form of corrosion, and do it without harm to boiler, fittings, packing or cutting cylinder lubricants, you can have your money back.

Write for book: "Boiler Troubles and Their Prevention."

BIRD-ARCHER CO.,

90 West Street, 20 **NEW YORK.**

Clean Water Means Clean Boilers



Buckeye Automatic Skimmer

This device floats on the water and traps all the impurities before they get a chance to do any harm. Thus the water is kept clean and the very causes of scale are removed. The "Buckeye" costs nothing to operate and it always works.

CIRCULAR ?

Buckeye Boiler Skimmer Co.

South End, Toledo, Ohio.

THE HAWK-EYE BOILER COMPOUND NEVER FAILED.

See our Advertisement in First Issue Every Month.

HAWK-EYE COMPOUND CO.,

303-304-305 Merrick Block, CHICAGO, ILL.

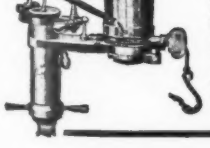
Pyramid Boiler Compound

Perfectly Harmless to the Boiler.
Absolutely Destructive to Scale.

Some territory still open for agents of the $5 000 class.

Binghamton Boiler Compound Co.,
Binghamton, New York.

Los Angeles, Cal.; Seattle, Wash.; Portland, Oregon; Cincinnati, Ohio; Cleveland, Ohio; Providence, R.I.; Syracuse, N. Y.; Scranton, Pa., Louisville, Ky.; St. Louis, Mo.; Birmingham, Ala.



The Wise Engineer Buys The Trill Triumph Indicator

He knows it doesn't pay to waste money experimenting with the "just-as-goods."

For accuracy, long life and high quality the "Trill" leads. WRITE FOR DESCRIPTION.

THE TRILL INDICATOR CO.,

Eagle Street, Corry, Pa.

Over 7500 Hammel Oil Burners

In use under Stationary Boilers, Locomotives, Kilns, Etc.

Write for Circular of Hammel Patent Furnace for Water-Tube Boilers

HAMMEL OIL BURNER CO.

609 North Main Street, LOS ANGELES, CAL.

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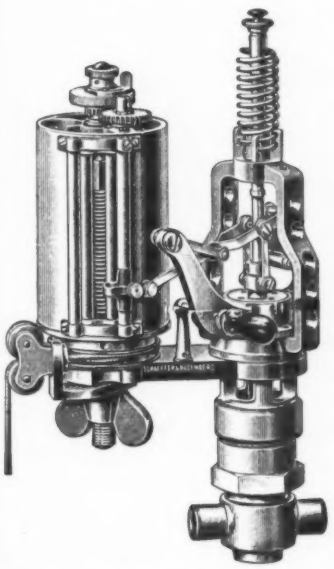

give accurate information, while momentary indications are very unreliable.

The S. & B. Thompson Continuous Card Indicator

is the only device which records conditions over a long enough time to give dependable results.

Our catalog will give you new ideas on this subject, it's free.

The Schaeffer & Budenberg Mfg. Co.

Main Office and Works:
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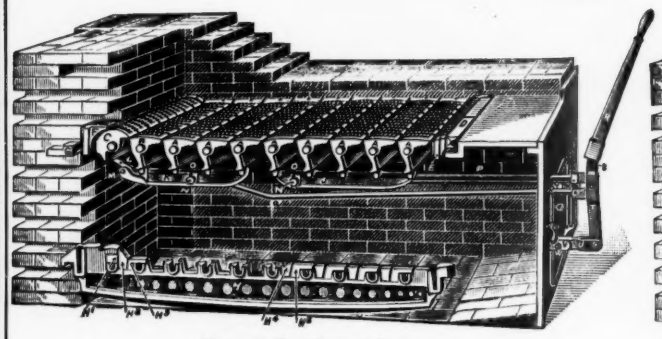
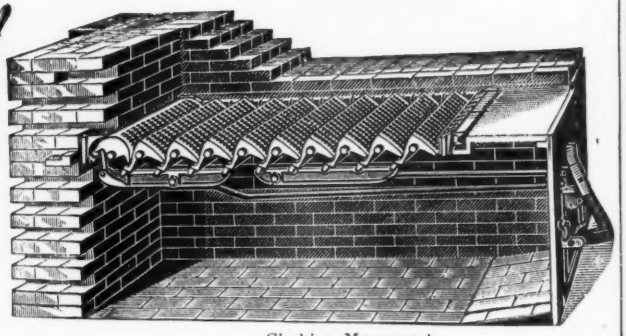
Argand Steam Blower

Get Big Results



Normal Position of Grate.



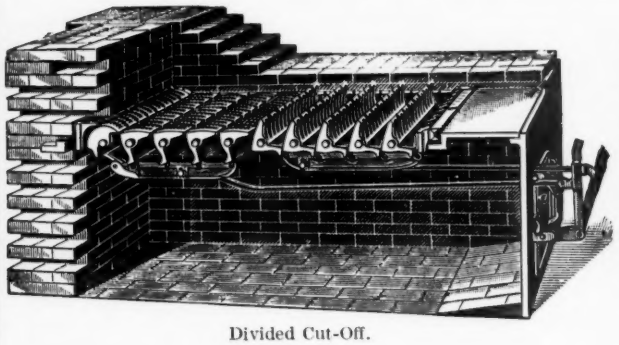
Shaking Movement.

From Cheap Fuel

by installing the McCLAVE GRATE and ARGAND BLOWER.

The McCLAVE SYSTEM does not burn **some** of the fuel—it burns **all** of the fuel, whether it be Anthracite Birdseye, Rice, Bituminous Slack, Screenings, Duff, etc. And it burns it in an even way that is extremely profitable to your pocketbook. Every possible heat unit is extracted.

The Argand Steam Blowers are something to blow about. They are far better than a natural draft and work in perfect unison with McCLAVE GRATES. The purpose of both is more power and less expense. Write for Catalog "D."



Divided Cut-Off.

Whole Cut-Off Movement.

McCLAVE-BROOKS COMPANY,

SCRANTON, PA.

BRANCH OFFICES: Charles N. Hays, Sales Agent, Fisher Building, Chicago; Empire Building, Pittsburg.

The Cost of Smoking

Chimneys equals fully 15% of your total fuel bills.

The Wilkinson Automatic Stoker and Smoke Preventer will save all this cost and a lot more beside.

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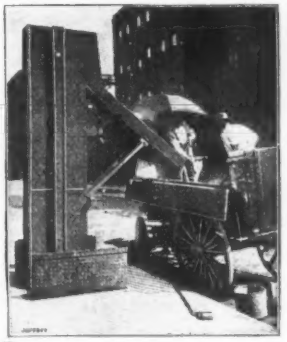
The Wilkinson Manufacturing Co.,
Bridgeport, Montgomery County, Pa.



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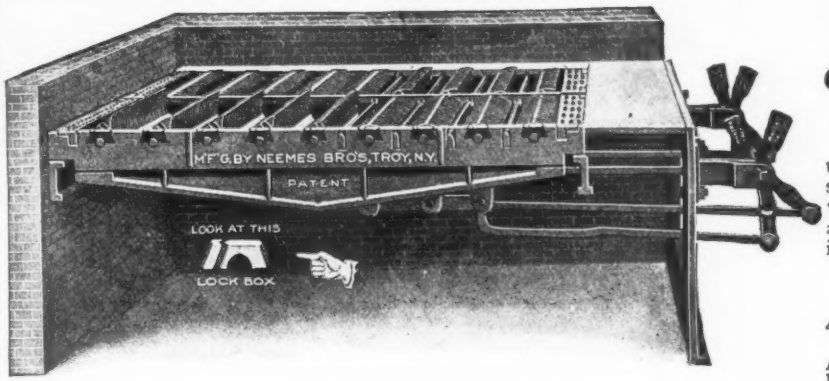
Jeffrey

Coal and Ashes Handling Systems for Power Plants.

THE JEFFREY MFG. CO., COLUMBUS, OHIO.

New York Chicago Boston St. Louis Denver Pittsburgh Montreal Knoxville



NEEMES BROS.

IMPROVED

Clinker Cutting, Shaking and Dumping Grate

unlike all other grates will cut from both sides of the shaker alike. Makes more steam with cheaper fuel and less of it. A slight agitation shakes out the ashes or a full opening dumps everything into the ashpit. *Write.*

NEEMES BROS.,
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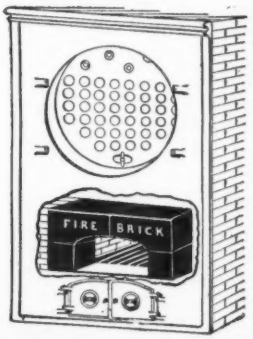
C. W. VAN BLARCOM, Room 533, Terminal Bldg., 30 Church St., Agent for New York City and vicinity BABCOCK & WILCOX, Ltd., Montreal, Canada, Sole makers for Canada BURKE ENGINEERING CO., 311 Industrial Bldg., Providence, R. I., Sole Agents for the New England States.

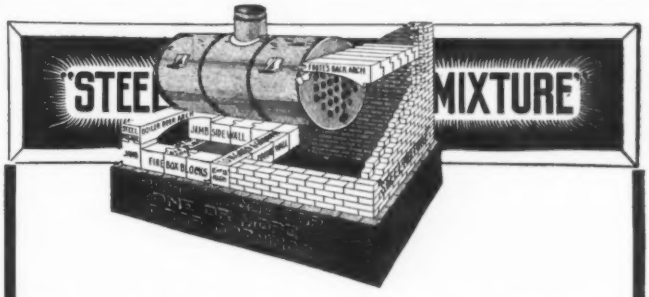
HEAT PROOF

The heat resistance of our fire brick is wonderful. We fit every type of boiler setting.

Write for catalog and prices.

Presbrey Fire Brick Works, Taunton, Mass.





FIRE BOX BLOCKS versus BRICKS

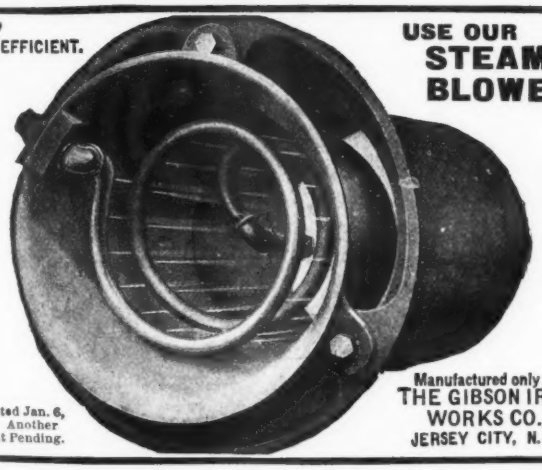
Brick work has four times as many joints as our Fire Box Blocks have. This means that our blocks have a comparatively smooth surface exposed to the fire. The natural result of this is that there is no chance for clinkers to form and no weak spots to start a general caving in of the fire box lining. The fewer joints make fewer air leaks too, and that's another point of economy.

The whole story is told in our "Dimension Booklet" which also contains directions for measuring. Write for this and join the procession of satisfied users.

McLEOD & HENRY CO., TROY, N. Y.

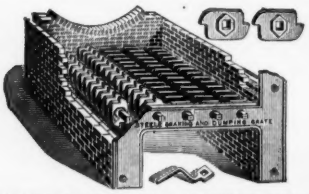
VERY EFFICIENT.

USE OUR **STEAM BLOWER**



Patented Jan. 6, 1903. Another Patent Pending.

Manufactured only by THE GIBSON IRON WORKS CO., JERSEY CITY, N. J.



THE STEELE SHAKING and DUMPING GRATE

SALAMANDER GRATES

Twenty different styles, all made of same grade of iron—the best for the purpose. On the market for 55 years. Tried and true.

SALAMANDER GRATE BAR CO.
126 Liberty Street, New York

ROGERS STATIONARY GRATE

COMMON PLAIN GRATE—SHIP BAR

Wing's Turbine Blower

enables you to secure a mechanical draft which will burn the cheapest grades of fuel with the highest results. Compact, durable and easily installed. Write!

L. J. WING MFG. CO.,
90 West St, cor. Cedar St., NEW YORK.

PREVENT SMOKE

Write to us for descriptive matter relating to a device that is mechanically correct, simple in construction, absolutely automatic, and its effectiveness in preventing smoke from Bituminous coal under any and all conditions has been fully demonstrated.

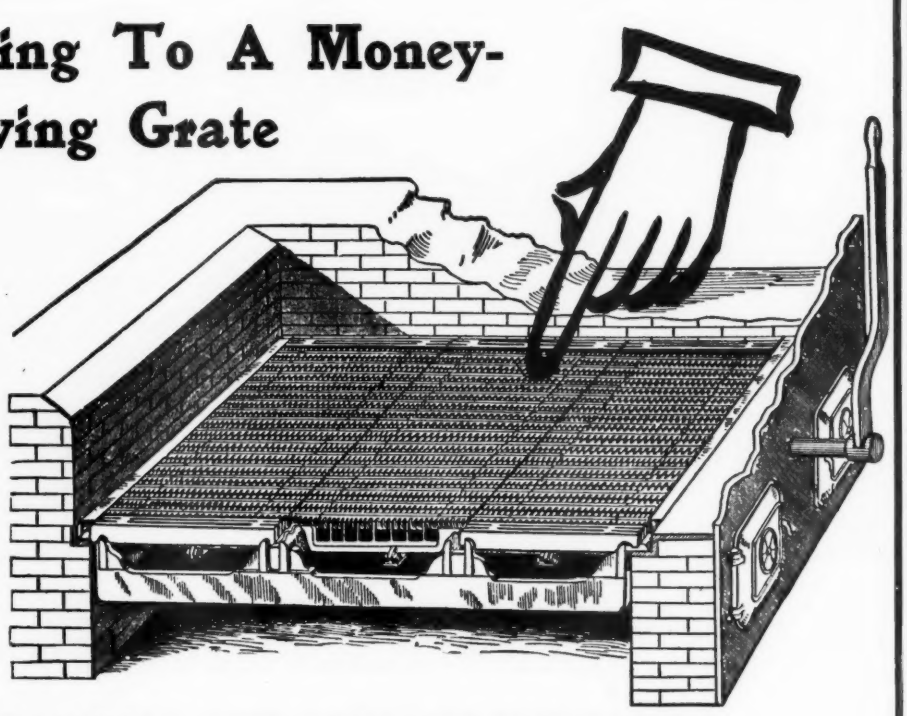
CLIMAX SMOKE PREVENTER COMPANY
205 Equitable Building, Boston, Mass.

We're Pointing To A Money-Saving Grate

The "Martin"

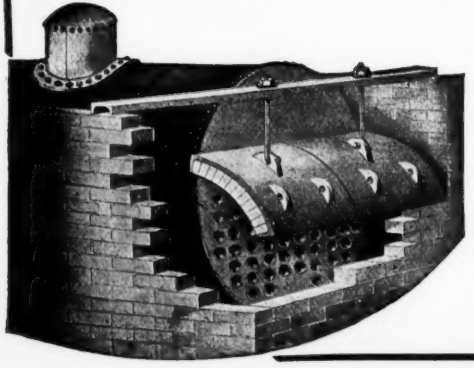
The secret of the money-saving powers of the Martin Grate lies in its construction. It gives better results with slack or screenings than most grates give with expensive fuel.

It can be installed without disturbing the brick work. If you are in line for a greater saving in the power room—ask for the details of the Martin Grate.



THE MARTIN GRATE COMPANY,
281 DEARBORN STREET :: :: :: CHICAGO, ILLINOIS

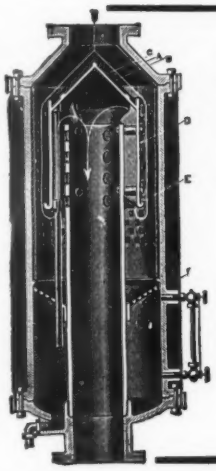
Monarch Boiler Arches Hang From Above!



in such a manner that plenty of room is allowed for expansion and there's no chance of crowding out the brick from the rear wall.

They are easy to set, remove or reset, and after you have installed one, we'll return your money if you don't like it. Send for booklet.

MAYVILLE SPECIALTY MFG. COMPANY
General Founders and Machinists
MAYVILLE, WIS.



SWEETS

Steam Separators deliver 99.8 dry steam and oil separators remove 99% of oil from exhaust steam. They *do* it that's all. All styles.

DIRECT SEPARATOR COMPANY,

712 S. Geddes St., Syracuse, N. Y.

CONTRACTORS.
CENTRAL STATION HEATING.

Write for valuable information.

AMERICAN DISTRICT STEAM CO.,
Lockport, N. Y. Toronto, Can. Chicago.

"SIROCCO"

TRADE MARK

FANS AND BLOWERS

BUILT ON THE TURBINE PRINCIPAL.

SIROCCO ENGINEERING CO., 138 Cedar Street, NEW YORK.
Chicago Office—510 Fisher Bldg., T. Lindberg, Mgr.
Pittsburg Office—1415 Keenan Bldg., F. K. Potter, Mgr.

GREEN CHAIN GRATE STOKERS

AUTOMATIC SELF-CLEANING SMOKELESS

GREEN ENGINEERING CO.
COMMERCIAL NATIONAL BANK BLDG., CHICAGO

GENERAL FOUNDRY WORK A SPECIALTY

ANY TYPE OF BOILER

The Murphy Automatic Smokeless Furnace

burns slack and other low cost fuels with unexcelled economy and absolute smokelessness. Strictly automatic in feeding and distribution of coal and the removal of the ash. Send for a complete description.

MURPHY IRON WORKS, 5 Walker St., DETROIT, MICH.

UNITS OF ANY SIZE

C-O-Two Furnace Tile

The best fire arch making material ever devised. Lasts longer. Increases combustion. Write for full description.

C-O-Two Furnace Co., Syracuse, N. Y.

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WIEDERHOLDT CONSTRUCTION CO.
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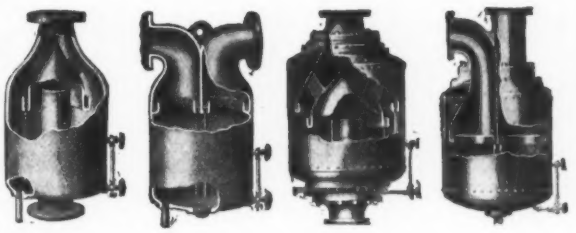
STEAM SEPARATORS OIL ELIMINATORS EXHAUST HEADS

If interested in above line, write for our NEW CATALOG illustrating and describing same.

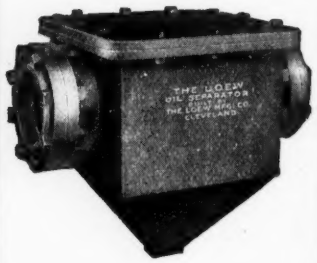


We are prepared to meet your requirements. Send specifications. Every machine GUARANTEED.

We also manufacture

LIVE STEAM FEED-WATER PURIFIERS and EXHAUST STEAM FEED-WATER HEATERS.

THE HOPPES MFG. CO.,
19 LARCH ST., SPRINGFIELD, OHIO.



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Steam and Oil

Guarantee the Highest Efficiency and Greatest Economy

The Steam Separator insures dry steam to the cylinder and prevents engine troubles, reduces fuel bills and adds to the efficiency of the engine.

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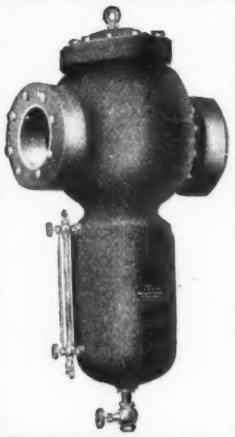

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THE largest contract ever awarded ior steam pipe and boiler coverings specified Carey's. This was the result of an exhaustive test conducted by the Manhattan Railway Company of New York, which proved Carey's Coverings to be more efficient and far superior in every way to any other of the numerous makes. No other coverings proved to be as light, clean and substantial.

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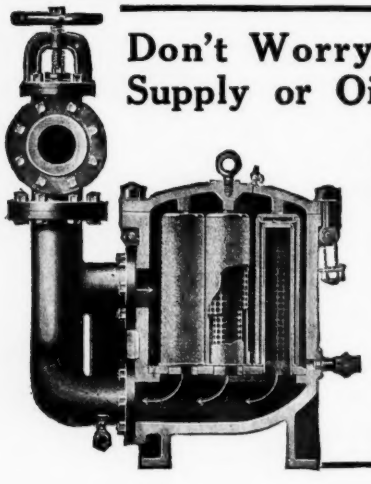

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Just Put A **BLACKBURN-SMITH FEED WATER FILTER AND GREASE EXTRACTOR**

in the feed line, and you have the one effective means of removing these impurities. Two SEPARATED layers of linen terry do the work. What the first layer doesn't catch, the second does. No other filter gives this DOUBLE filtration, or can be kept clean with so little effort or expense.

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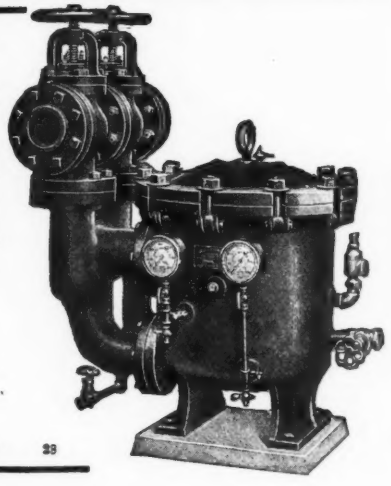

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IS NECESSARY.

THE GEIPEL STEAM TRAP

SPEAKS FOR ITSELF.

SEND FOR DESCRIPTIVE CIRCULARS.

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RESULTS

nd take your time about it We'll ship the *Baum Separator* to you subject to 30 days' trial. If it doesn't make good—send it back.

The Baum removes all oil, water, grit, etc., from live or exhaust steam. If you're out for saving money prove it by writing for a catalog.

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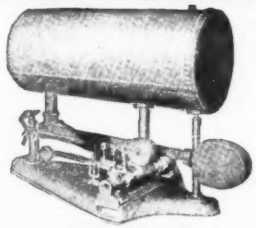
FREE OUR SPLENDID CATALOG



It tells all about the "Trap that Tilts." What do you think of a steam trap that **works while you watch it.** That's the **"Morehead"** —the novel trap that's operated by *gravity*. Send us your name and address—a catalog will start your way *instantly*.

MOREHEAD MANUFACTURING CO.
1051 GRAND RIVER AVE., DETROIT, MICH.

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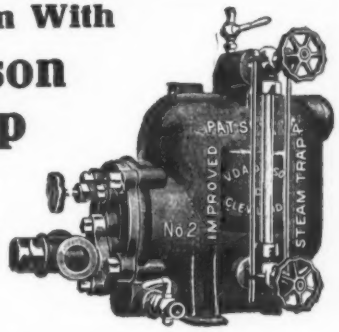
An Anderson Steam Trap



and you will save coal, repairs and time.

Valves and valve seats are phosphor bronze of simple construction and easily accessible.

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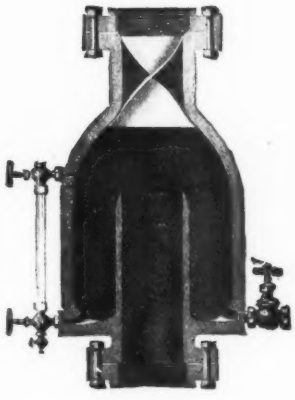
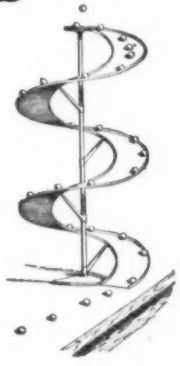


The Principle Of The

"SWARTWOUT" STEAM SPECIALTIES



is as simple as the children's familiar toy. The helical tube gives the steam a rapid whirling motion. The result is complete water and oil separation without resistance to the steam flow, or loss of pressure.

THE OHIO BLOWER COMPANY,

CLEVELAND, OHIO.

Also manufacturers of "Swartwout" Gravity Closing Ventilators. 1—71

This Costs Nothing

We claim that much money can be saved by the judicious installation of

Marck Steam Traps

on your steam system.

We are willing to show our confidence in our opinion by the following liberal offer.

If you will send us a drawing of your system we shall send you suggestions as to where to locate traps together with illustrated catalog.

If you desire to follow our suggestions all or in part, we will send you the necessary traps with the understanding that if after 30 days' test you desire to return all or any of the traps you can do so and we will cancel the charge in full.

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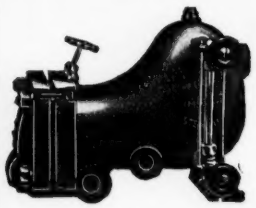

McDANIEL STEAM TRAPS

are especially adapted for draining steam separators and high pressure mains. Also good for steam heating. All working parts are attached to the bonnet, and are removable with it. Valve outlets are large, to give rapid discharges of condensation.

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should be used on all steam pumps where a fixed discharge pressure is desired.

The construction permits of easy access to the stuffing box for removing packing, and the spring can be adjusted or entirely removed without interfering with any other part of the valve. Any practical man will readily see its advantages.

All our goods are made in our own factory and tested before shipping. We guarantee them to give perfect satisfaction. Established 1878.

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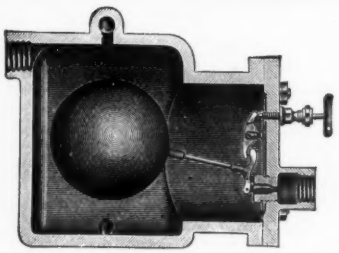

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That's the "RELIANCE."

It's never trapped into failing to operate at the right time. It has fewer and simpler parts than any other trap and handles more water, size for size. The float is guaranteed for one year to neither fill nor collapse.

Other superior features too numerous to mention here. *Write for Circular.*

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ERIE CITY OPEN TYPE FEED WATER HEATERS

contain our own especially designed inlet head and trays.

They have a deflecting plate which prevents any water, coming in contact with the sides of the heater, from flowing out through the overflow.

These are but two of the many exclusive features, *all of which are patented*, that our heaters contain. They are all fully explained in a splendidly illustrated catalogue.

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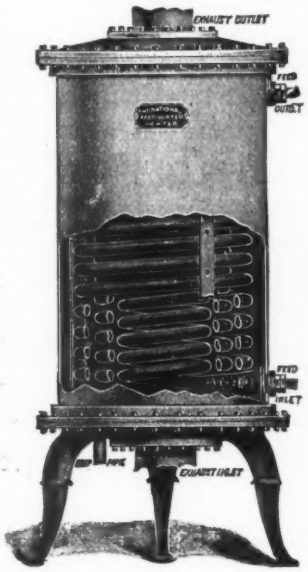
INSIDE INFORMATION

No inside joints or straight tubes to leak, but in their place the finest quality seamless drawn brass or copper coils. No back pressure and no contact of the water with the shell or iron. Thus the troubles, so common to ordinary feed water heaters are dispensed with in the *"National."* It is the heater of *ideal* construction and the utmost simplicity. Over 1,200-000 H. P. in present use.



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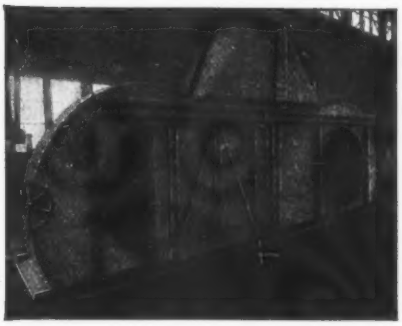

To figure this out we will need certain data as indicated below, but we will be glad to give you the benefit of our experience in the construction and operation of a large number and variety of mechanical draft plants if you will give us the information. We make no charge for this engineering service, although it may not in all cases lead to business for ourselves, since we consider it essential in the permanency of our business to give our customers competent and conscientious advice in regard to the actual earning capacity of the apparatus which they propose to put in. The data needed for an estimate are as follows:

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2. Average amount of coal burned per hour.
3. The greatest rate of evaporation at any period during the day or year.
4. The character of the coal used.
5. The kind of grate bars.
6. The number, type and size of the boilers.
7. The size and length of flues, also number of bends.
8. The size and height of chimney.
9. The intensity of draft obtained with the present chimney at the base of chimney.
10. The draft obtained in the furnace at present.
11. The thickness of fuel bed usually carried.
12. Steam pressure.
13. How much exhaust steam at atmospheric pressure is there at present available in the plant and in what manner is it utilized?
14. Is it desired to increase the capacity of the plant at any future time, and if so, by how much?
15. If possible, information, plans or drawings should be supplied which will show the space available for the location of forced or induced draft fans, flues, etc.

Ask for Bulletin "108 P" on Mechanical Draft.

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Matteawan, N. Y.

New York City, Boston, Chicago, Atlanta, San Francisco, Los Angeles, Seattle, Salt Lake City, Montreal.

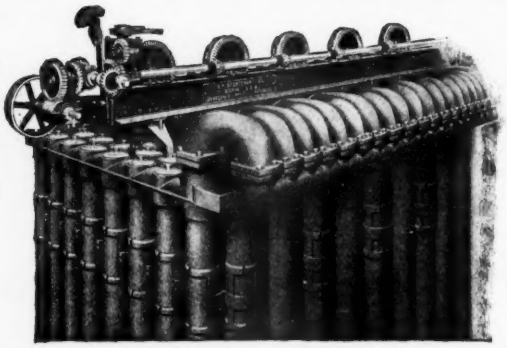
Engineers; Builders of Green's Fuel Economizers, Fans, Blowers and Exhausters, Steam Air Heater Coils, Waste Heat Air Heaters, Mechanical Draft, Heating and Ventilating and Drying Apparatus, Draft Dampers and Engines. 123

OUR ENGINEERS

will explain in detail the

STURTEVANT ECONOMIZER

and help you plan the BEST INSTALLATION for Utilizing the Heat now Escaping from your stack.



Built for pressures up to 300 Pounds per square inch.

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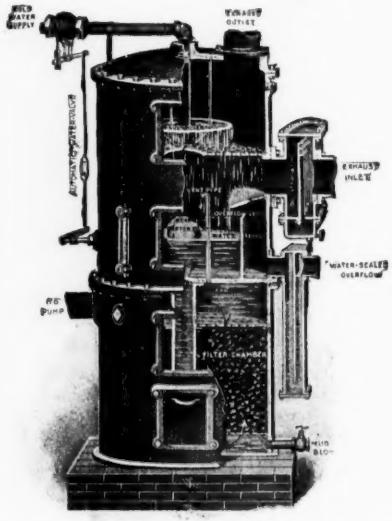
THE WHITLOCK OPEN EXHAUST
Feed Water Heater and Purifier



Perfect Oil Separation. Easily Cleaned. The Highest Possible Temperature in the Feed Water.

Manufactured by

THE WHITLOCK COIL PIPE COMPANY,

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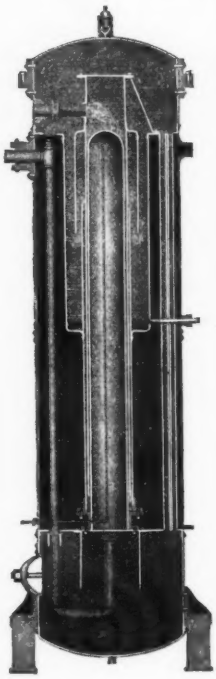
WE MAKE IT TOO HOT FOR SCALE



The Eclipse Feed Water Heater and Purifier, using live steam, heats the water to 300° and thus causes the scale-forming impurities to separate. It gets better results more economically than any other feed water heating device known.

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The Eclipse Feed Water Heater and Purifier Company,

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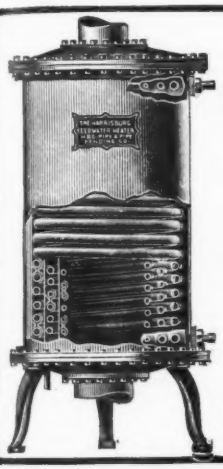

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Guaranteed to be the most effective, most durable and cheapest heater manufactured.

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Coils and Bends of any desired shape. Manufacturers of High Grade Wrought Iron Pipe, Black or Galvanized. Write for descriptive catalog.

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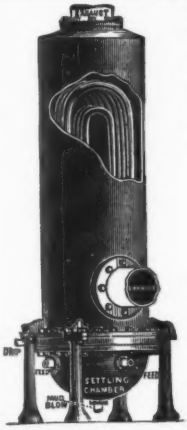

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is escaping through your exhaust pipe. The **Patterson-Berryman** Feed Water Heater and Purifier will divert this stream of money to your pocket.

We will send the heater on trial

Free For 60 Days

and if you are not satisfied that it will pay for itself many times over, you may return it at our expense.

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One Square Foot Heating Surface for Each Horse Power

For heating water to 212° with exhaust steam—

For eliminating impurities—

For easy cleaning, cheap maintenance and long durability—

The Otis Tubular Feed Water Heater and Purifier

has no equal.

We guarantee satisfaction and to prove our guarantee we send the Otis on trial—you to be the judge—and, if you are not entirely satisfied, it will not cost you one cent, even for return charges.

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Every Coil a Spring

Reilly Multicoil FEED WATER HEATER

IN AN ADVERTISEMENT we cannot describe all the advantages of this heater. We therefore ask you to write for our Catalog.

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and you will discover new ways to improve.

This indicator furnishes permanent daily and hourly records.

This meter is also adapted to the measurement of water, of air, and other gases.

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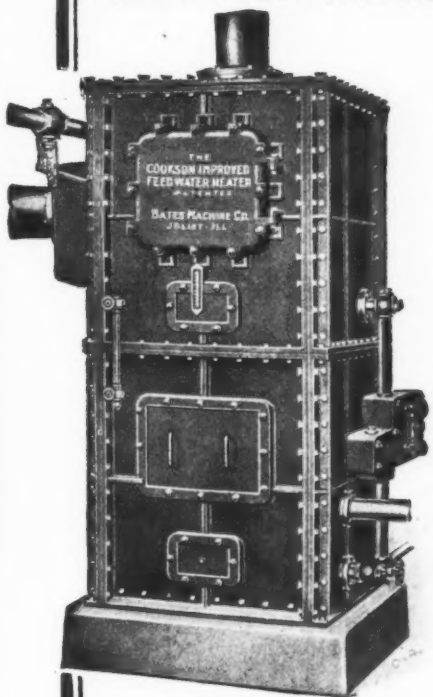
The St. John Indicating and Recording Steam Meter

COOKSON STANDARD ALL CAST IRON FEED WATER HEATERS



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Dry Steam for Heating Purposes.

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Lime Catching Pans. Especially Adapted for use with Heating Systems, Dryers, Etc.

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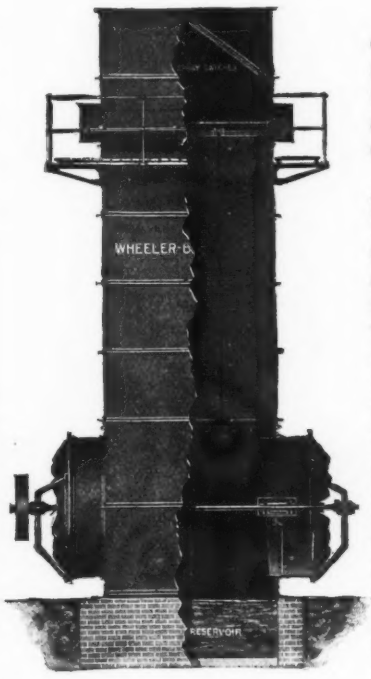
In Cooling Towers It Is Surface Exposed and Circulation That Count



The principal cooling effect in a water cooling tower, a pond, or a spray is from evaporation.

Evaporation is proportional to the water surface exposed, but stops as soon as the air in contact with the water becomes saturated. The trick, therefore, is to have as large a water surface as possible and to keep the air in contact with the water in rapid circulation. This is why cooling towers are so much better than sprays or ponds

and why the

Wheeler-Barnard Water Cooling Tower

is the best of all.

In the Wheeler-Barnard Tower the water trickles down over a metallic mat, the drops rolling over and over as they go. The mat, while presenting a large surface of water to the air, is so arranged that the flow of the air upward through the tower is unobstructed, thus giving a large and rapid circulation of air in natural draft towers and requiring but a small expenditure of power in fan towers.

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If you want cold water for any purpose whatsoever, describe your conditions, and our engineering department will be pleased to make estimates and suggestions.

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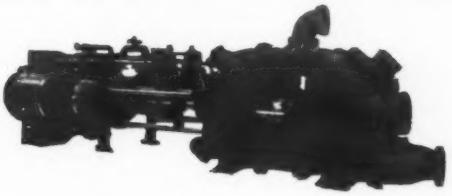
WHEELER
CONDENSER & ENGINEERING CO.
CARTERET, NEW JERSEY.

Warren Steam Pump Co.

Warren, Mass.

PUMPS FOR ALL REQUIREMENTS.



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Air Pumps and Jet Condensers, Combined Air and Circulating, and Marine. *Catalog.*

Deming

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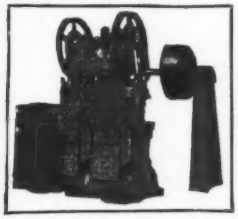

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For operation by any power. **Pumps**

The Deming Company

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Condensers, Cooling Towers, Vacuum Pumps, Heaters

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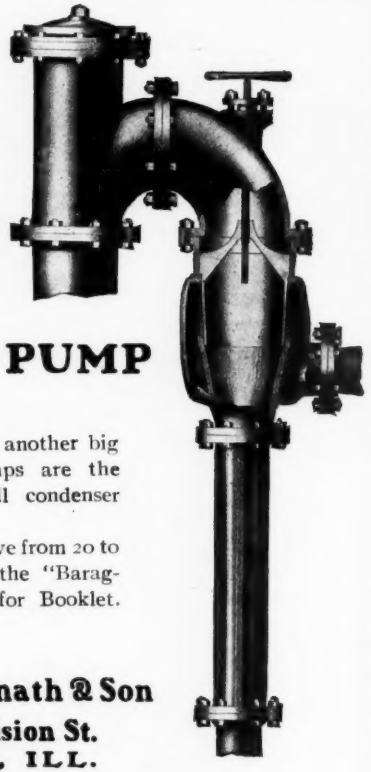
Our No. 4 Hand Tachometers will register speeds in either direction from 30 to 4,000 revolutions per minute. Only one spindle required for all four speed ranges. The change from one speed range to another can be effected while the Tachometer is in use, by pushing the thumb slide on the face up or down. *Send for Catalogue.*

Schuchardt & Schutte,

136 Liberty Street, - New York.

CLOSE REGULATION

of the water supply is one of the qualities found in the Baragwanath Syphon Condenser. It is *the only condenser* having an adjustable water nozzle.



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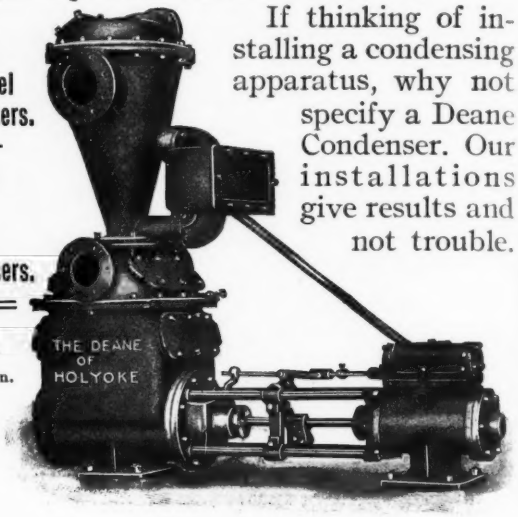

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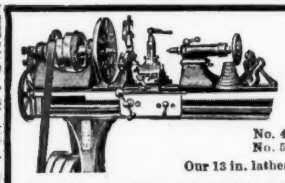

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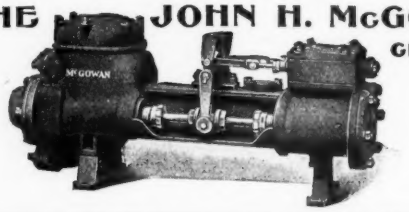

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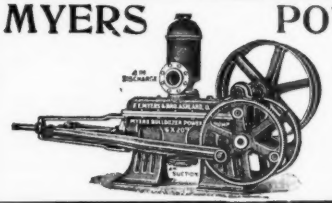

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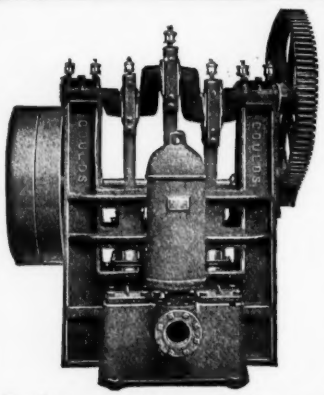

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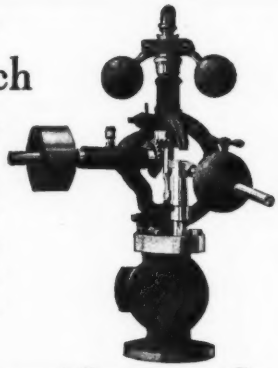

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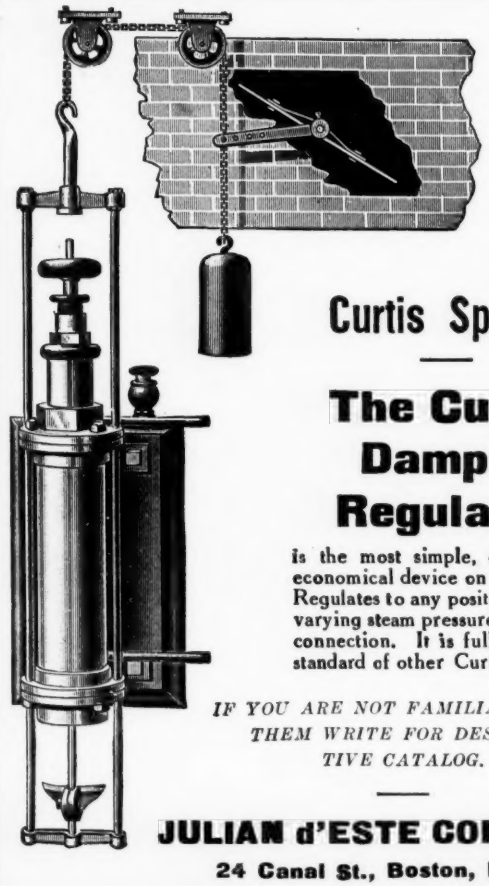

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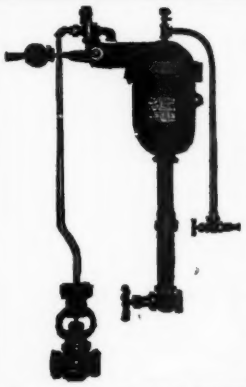

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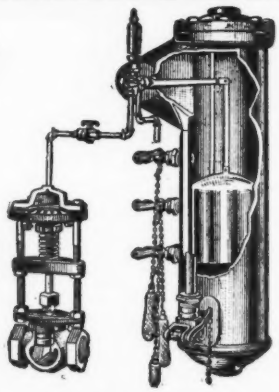

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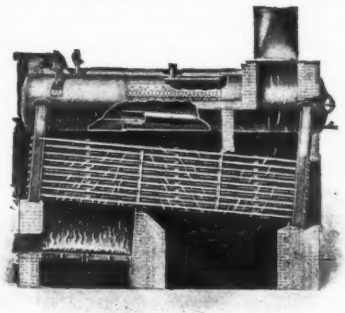

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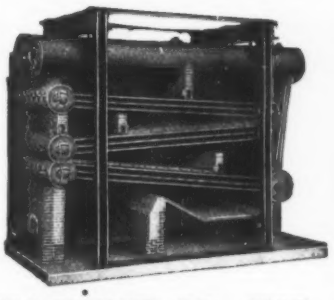

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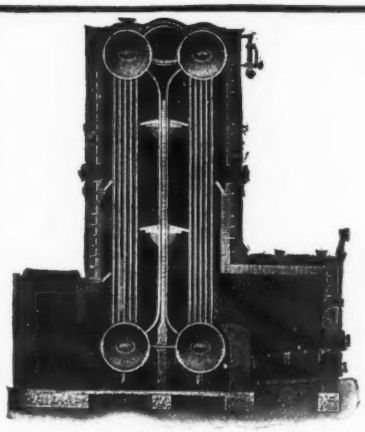

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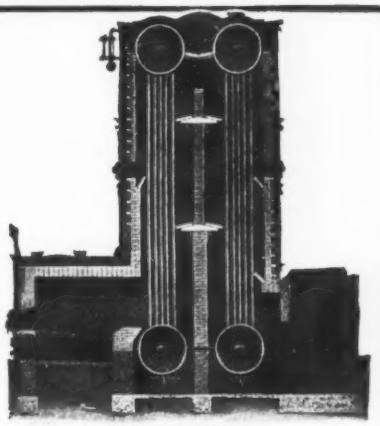

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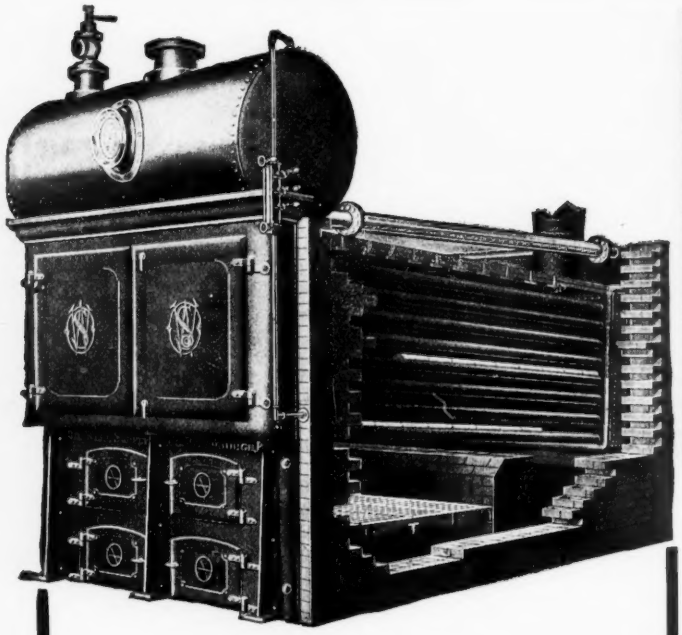

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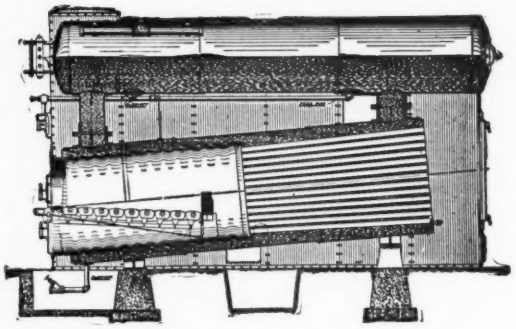

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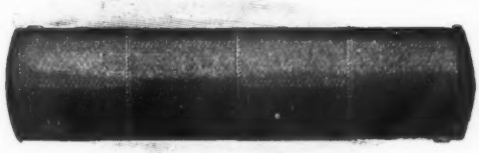

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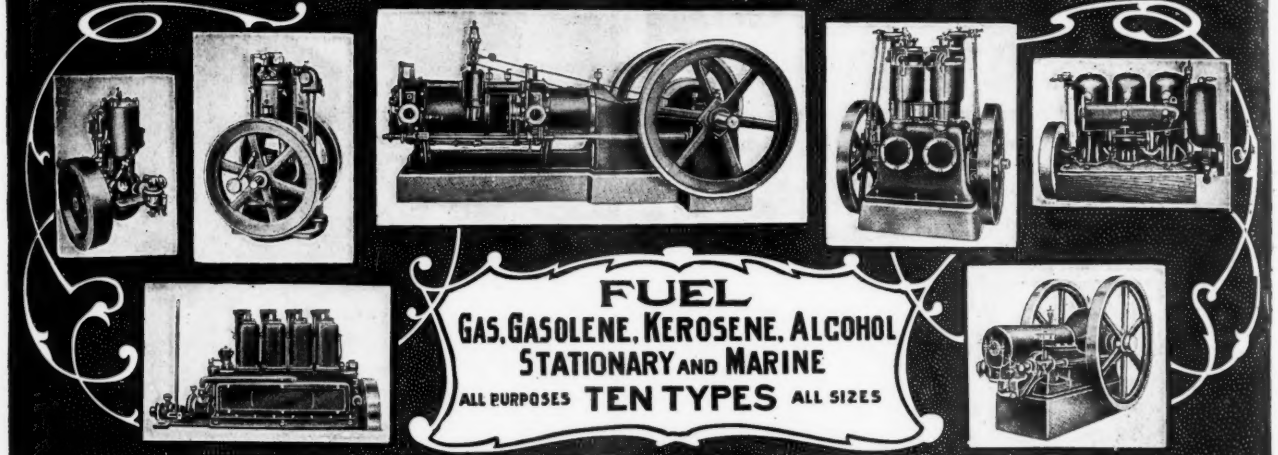

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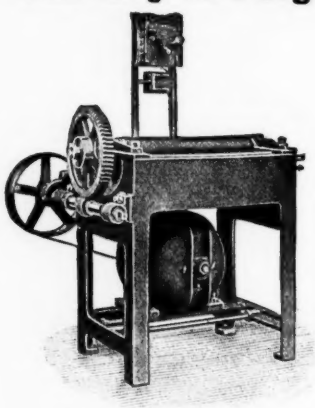

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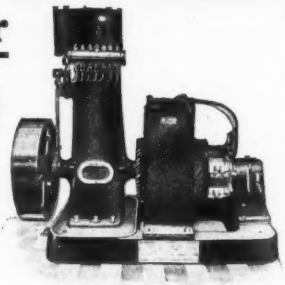

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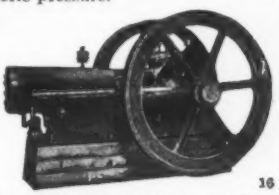

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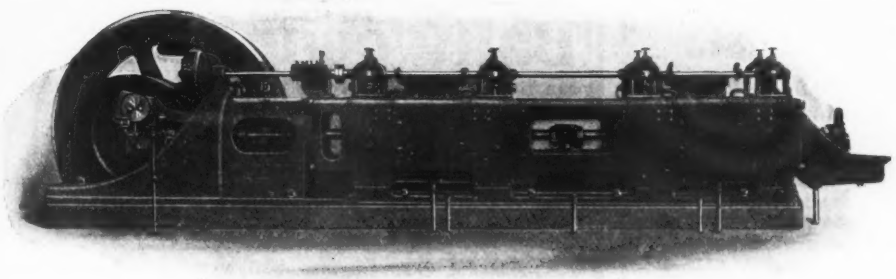

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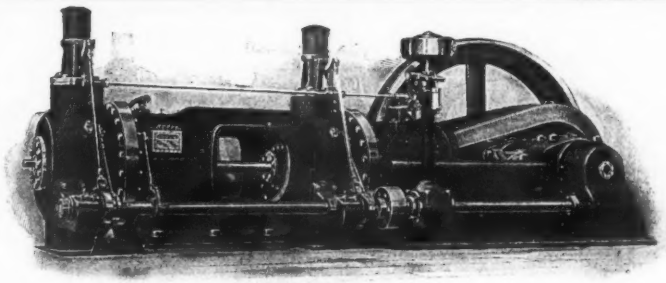

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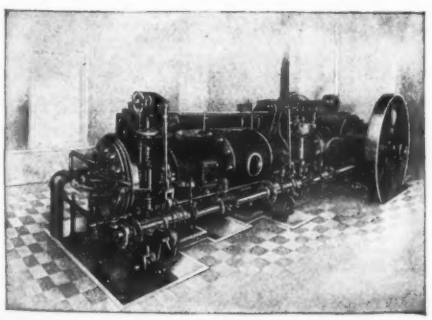
ENGINES OF VERTICAL AND HORIZONTAL TYPES

75,000 HORSE POWER IN SUCCESSFUL OPERATION

STRUTHERS-WELLS COMPANY, - - - Warren, Penna.

The Engineer's Choice Is The Sturdy "Du Bois,"



the Gas Engine that most perfectly combines practicability, durability and simplicity. It has the weight and strength necessary to withstand the continuous high pressure of explosions, and the absolute governor control which means great fuel economy. Catalog ?

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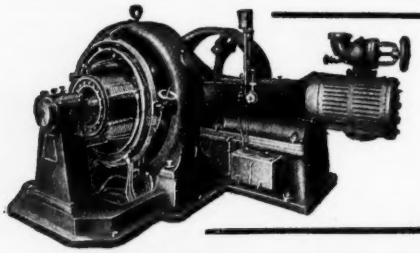

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THE STEAM TIGHT VALVE KIND

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U.S. METAL POLISH — Economical — Brilliant — Infallible — G. W. Hoffman, Sole Prop. 295 E. Wash. St. Indianapolis, Ind. — For Polishing Gold, Silver, Plated Ware, Nickel, Tin, Brass, Copper, Etc. — Directions: Take a little of the Polish on a soft cloth, rub the Metal hard and then wipe it off with a dry cloth — For Experiments — Accomplishes Success

THE ONLY METAL POLISH

that works quick and easy and keeps its lustre. Holds old trade and makes new. IT DOES NOT DETERIORATE. Established 16 years.

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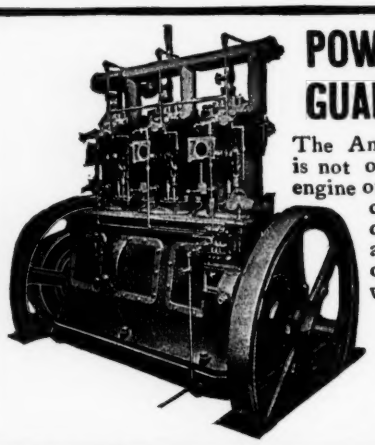

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The American Diesel Engine is not only the most efficient engine on earth but it burns the cheapest liquid fuel—crude oil. We can guarantee a cost which no other engine can develop under test.

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are slightly higher in cost, but this is *more than justified* by their wonderful economy, efficiency and durability. No other "prime movers" possess Ballwood Quality. We build

Single Valve

Center Crank, Automatic Cut-off Engines, single cyinder and compound;

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Also Welded Flanged Pipe And Bends

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Continuous Industrial Alcohol Distillery Apparatus,

for light, heat and power purposes from natural gas and Portable Stills for vegetable waste matter. Economy and rapidity of construction a specialty. Unquestionable references.

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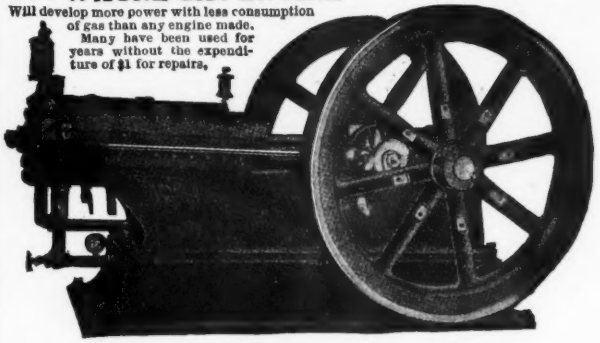
THE WAYNE GAS ENGINE Gas Producers from 35 H. P. up.

Will develop more power with less consumption of gas than any engine made. Many have been used for years without the expenditure of $1 for repairs.



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BUILDERS OF HIGH CLASS

STEAM AND GAS ENGINES

HIGH IN DUTY, SUPERIOR IN REGULATION

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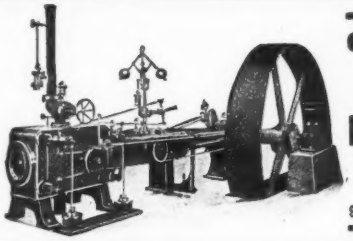

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Refrigerating and Ice Making Machinery

THE VILTER MFG. CO.
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Our machines operate constantly—sometimes twenty-four hours a day for years—under the severest possible operating conditions. Northern equipments endure in moist or dusty localities. They give constant, economical power and light ¶Whether your service is severe or easy you will find Northern machines well suited to your work. At any rate you ought to investigate this to prove that we are right or wrong. Get Bulletin 838 and tell us what you want to do with electric power. 895

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When you buy an engine, you expect many years of service from it. The cost for repairs during those years may or may not greatly exceed the original cost of the engine. Buy the SHEPHERD to keep on the safe side—catalog tells why.

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We Manufacture
AN ECONOMICAL AND DURABLE ROTARY ENGINE
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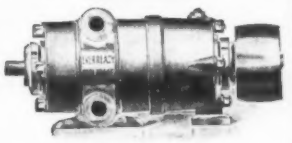

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ACCURATE REGULATION FOR ELECTRIC SERVICE-AUTOMATIC CUT-OFF AND RITES FLY-WHEEL GOVERNOR
A.H. ALBERGER COMPANY
45 TO 600 H.P. USING NATURAL GAS
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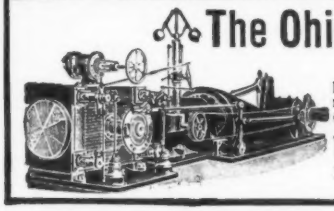
695-697 ELLICOTT SQ. BUFFALO, N.Y.

The Ohio Corliss Engine



For hard work, heavy loads and high-speed, the Ohio shows close regulation and runs smoothly and quietly.

THE GRIFFITH & WEDGE CO.
Est. 1840. ZANESVILLE, OHIO

"The Reeves" "C"

is the new Bearing Metal that is different and better than any other. Try it—you'll say it's by far the best you ever used. Sells at your dealers for 25c a pound. If he isn't wide awake enough to keep it, write us direct for a 50 lb. trial box.

Sold by leading jobbers in nearly every jobbing center of the United States. Send for address of nearest agent to you.

Reeves Pulley Co., Columbus, Ind.

Fitchburg Engines

have all the good qualities of other Engines together with certain exclusive features that count for higher efficiency and lower operating expense.

Fitchburg engines keep steam tight for 25 years with one hour's attention a year.

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Fitchburg Steam Engine Co., Fitchburg, Mass.

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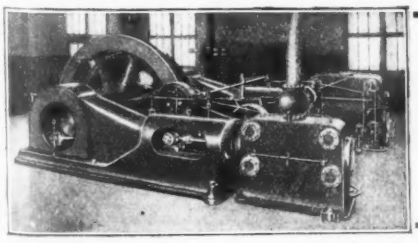

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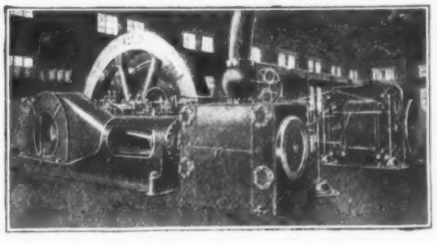
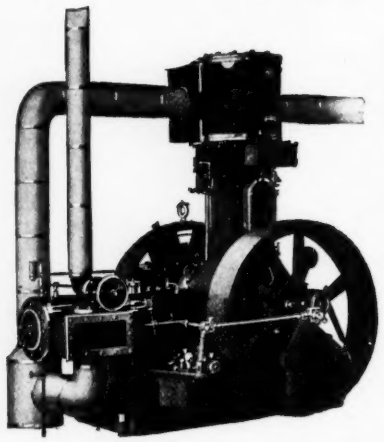
Speeds Higher than other Corliss types. For direct connection to Generators in sizes from 100 K.W. to 7500 K.W., also belt and rope drive or direct connected to a line shaft.

Designed and Built by

Providence Engineering Works,
Main Office and Works, PROVIDENCE, R. I.



The Engine For Upper Floors



A single piston engine cannot be exactly balanced. If no counter balance weights are put on, powerful forces due to the rapid starting and stopping of the piston, piston rod and connecting rod tend to push the engine frame to and fro.

If a counterbalance just heavy enough to neutralize these forces is put on, equal unbalanced forces are created in a direction at right angles. The engine tends to hop up and down on its foundations.

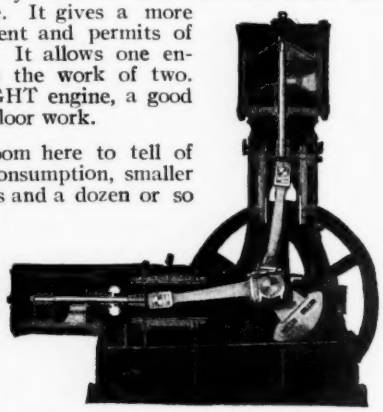
Neither the horizontal nor the vertical forces of an engine running at high speed are good for the concrete-steel second story floor nor for a steel frame or brick or stone building. They tend to loosen joints and to shake the building down, to say nothing of racking nerves.

How then is such vibration to be avoided? By installing an

American-Ball Angle-Compound Engine

in which the unbalanced forces of two pistons set at right angles are combined so that their resultant can be balanced perfectly in all positions by one counterweight. This balancing saves not only the joints of the building, but also the joints of the engine, since it is only through the bearings that unbalanced forces can be transmitted from moving parts to the engine frame and foundations. The angle-compound therefore, not only runs smoother, but lasts longer.

Putting two cylinders at work on one crank has another advantage. It gives a more even turning moment and permits of a lighter flywheel. It allows one engine frame to do the work of two. The result is a LIGHT engine, a good quality in second floor work.



We haven't room here to tell of the lower steam consumption, smaller space requirements and a dozen or so other advantages possessed only by the American-Ball Angle-Compound Engine, but you will find them concisely described in our 32-page book which we would be glad to send upon request. 10

The American Engine Co.,
22 Raritan Avenue **BOUND BROOK, N. J.**

Lammert & Mann

Engineers and Machinists

157 S. Jefferson Street, CHICAGO

WE MAKE A SPECIALTY OF

Corliss Engine Repairs. Engines Indicated.
General Jobbing. Repairing Engines.
Pumps, etc., all kinds Special Machinery.
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"True In The Long Run."

"YOUNGER TRIUMPH"

A little duplicate of the regular Triumph compressor. Built to make only from 2 to 3½ tons of ice, it performs its work as economically as our 50 ton compressor. The Younger Triumph is "True In The Long Run."

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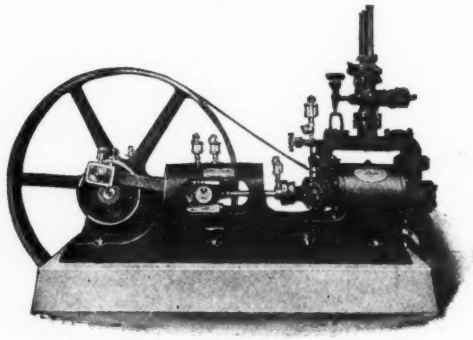

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York Manufacturing Co.

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We manufacture all machinery and parts needed to equip a complete Ice or Refrigerating plant—

Machines, Condensers, Tanks, Cans, Coolers, Piping, Boilers and Ammonia Fittings

of all kinds. We employ over 1,250 men in the manufacture of Ice and Refrigerating Machinery exclusively. Catalogue sent upon request.

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20 x 42 Allis, Corliss	16 x 32 Buckeye, Automatic
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14 x 24 Wright, Corliss	12 x 18 Brownell, Automatic
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Also large assortment of Automatic and Throttling Engines of other sizes.

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Heaters, Pumps, Tanks, Saw Mills, Iron Working Tools, etc., etc.

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We are the sole manufacturers of the celebrated "Leader" Injectors and Jet Pumps.

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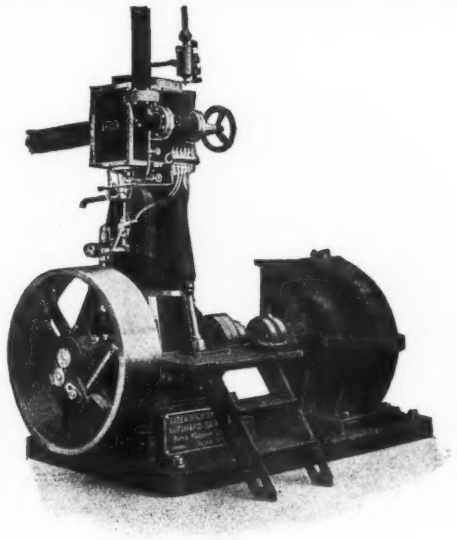

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WATER WORKS, IRRIGATION

and other places where it is desired to move a large volume of water at small expense.

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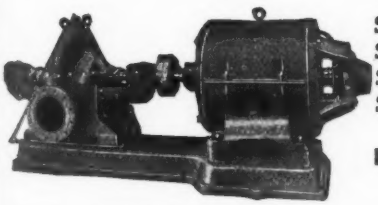

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Steam Turbine Motors
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Curtis Turbine Generators also Appeal to Power Plant Owners

Because

the turbine may be installed on a small and inexpensive foundation without heavy or rigid support, as it runs without strain on foundations

and

operates satisfactorily in any place where noise and vibration cannot be tolerated and where clean operation and small oiling expense is appreciated—

because

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Curtis Turbine Generators need only to be known to be appreciated by all.

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We're Anxious To Answer Any Engine Questions You May Wish To Put To Us

The points that go to make up a highly efficient, durable, economical engine are of interest to every power man. Those points are more highly developed in Wisconsin Engines than in any others. Here's a question for you—What is a "Complete Expansion" Gas Engine?

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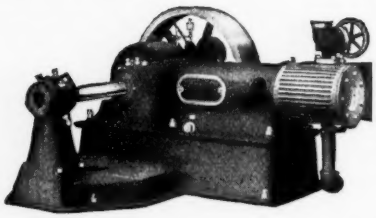

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The Frame—Heavy and rigid. Bored guide type. Perfect alignment, cool bearings, noiseless running.

The Cylinder—Close-grained, remelted iron.

The Governor—The Riblet Automatic Governor—*always reliable.* Closest regulation. Better than any other.

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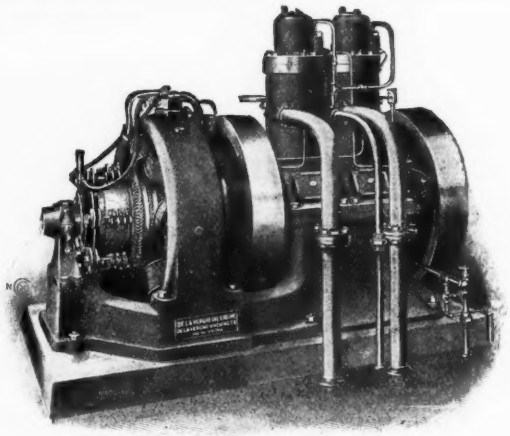

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are cheaper, simpler. more compact than any other motive power. 8 H. P. hours per gallon of cheap oil.

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The "De La Vergne" Vertical two-Cycle 4 to 25 H. P.
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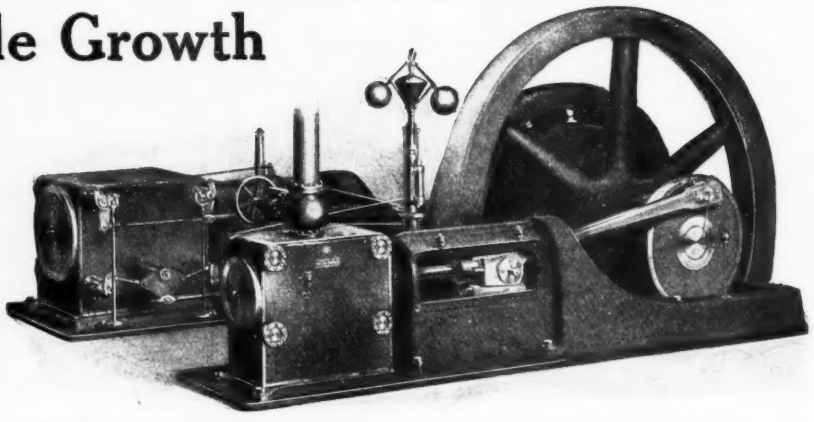

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That's what we'll do the instant you give us the word. If your Cylinder needs reboring, or any other engine troubles arise, there's no necessity of knocking down your engine. We are expert engine repairers and can rebore your cylinder right in position. You'll save money by sending for us.

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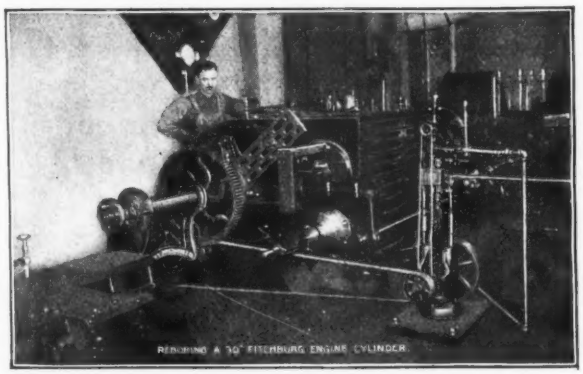

REBORING A 30" FITCHBURG ENGINE CYLINDER.

H. B. UNDERWOOD & CO.,

ESTABLISHED 1870

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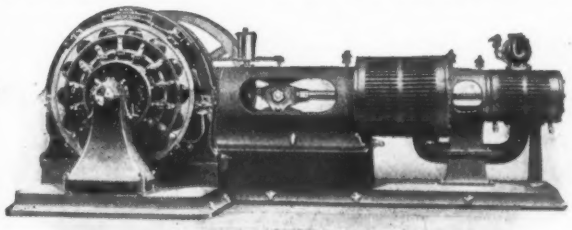
THEY GET ALONG WELL TOGETHER



If your Dynamo is not made for your Engine, or vice versa, there's likely to be trouble. But if each is made to run with the other, such as Ridgway Dynamos and Engines, then perfect harmony is bound to result between them. You'll appreciate this unison even more, if your plant is "Over the hills and far away," where a breakdown is a real serious matter and repairs hard to 'tend to.

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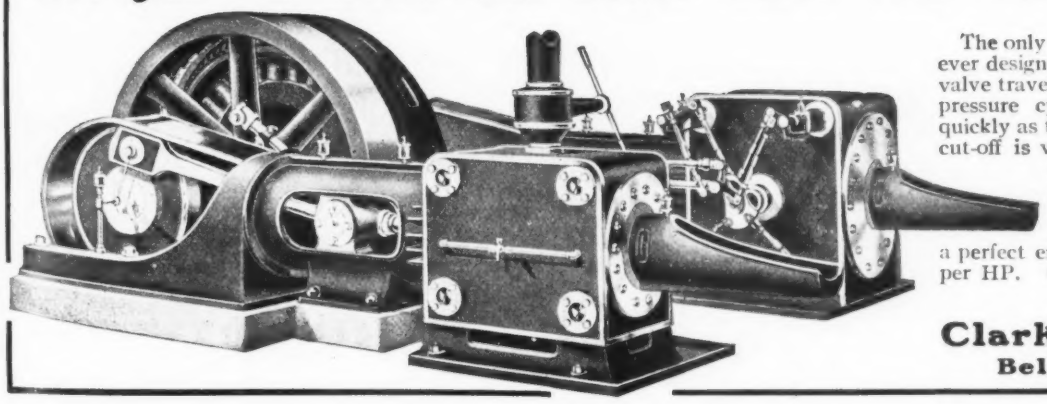
Ridgway Dynamo & Engine Company,

Works, Ridgway, Pa., U. S. A.

Not Just As Good But Better Than Any Other Engine



The only cross compound engine ever designed having an unvarying valve travel on both high and low pressure cylinders. Cuts off as quickly as the releasing Corliss and cut-off is varied simultaneously in both cylinders. Built for speeds as high as 200 r.p.m. and any desired pressure. We offer a perfect engine at the right price per HP. Catalog free.

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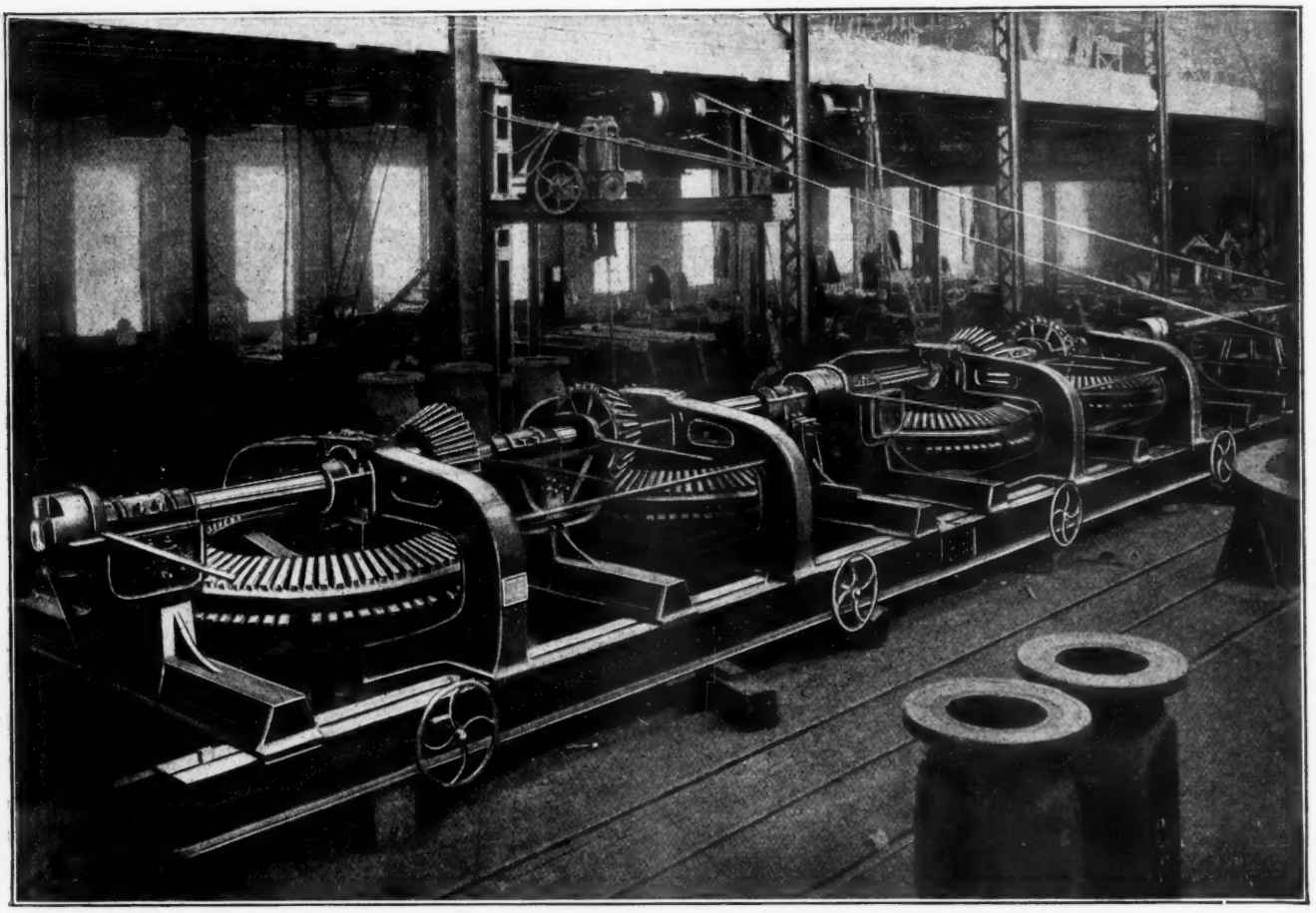

The above cut shows Water Wheel Harness on erecting floor in our Machine Shop built by us for Janesville Contracting Company, Janesville, Wis.

One Shaft 2 3/16″ x 65′ 11″, one Shaft 6 15/16″ x 24′ 0″, one Shaft 5 15/16″ x 24′ 0″, one Shaft 4 15/16″ x 17′ 11″, four Shafts 5 7/16″ x 9′ 7″, four Shafts 2 3/16″ x 8′ 3″, together with bevel core wheels, pinions, shifting gears, bridge trees, clutches, etc., were employed in its makeup.

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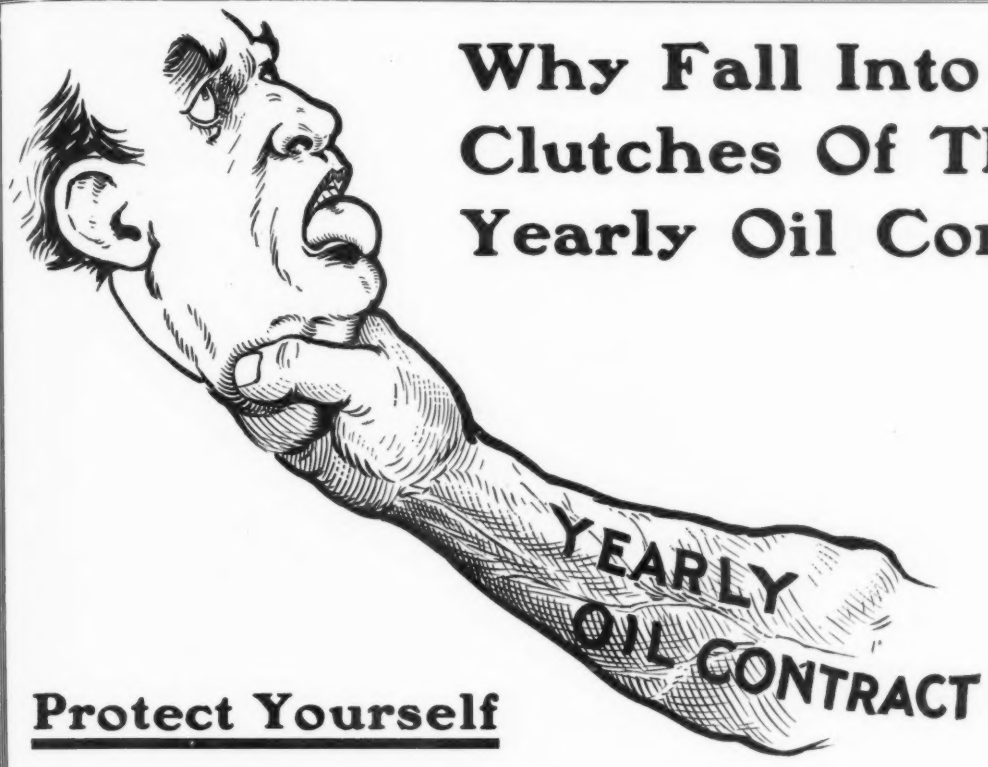
We make the Twin City Corliss Engines; have manufactured them for many years and installed them in every kind of service all over the United States. The first two engines we built and sold about 20 years ago are still doing good service. Our customers of old are the best friends we have today. Ask them what they think of our Twin City CORLISS ENGINE.

MINNEAPOLIS STEEL & MACHINERY CO.,

MINNEAPOLIS.



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By Using Keystone Grease

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See our advertisement on page three.

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